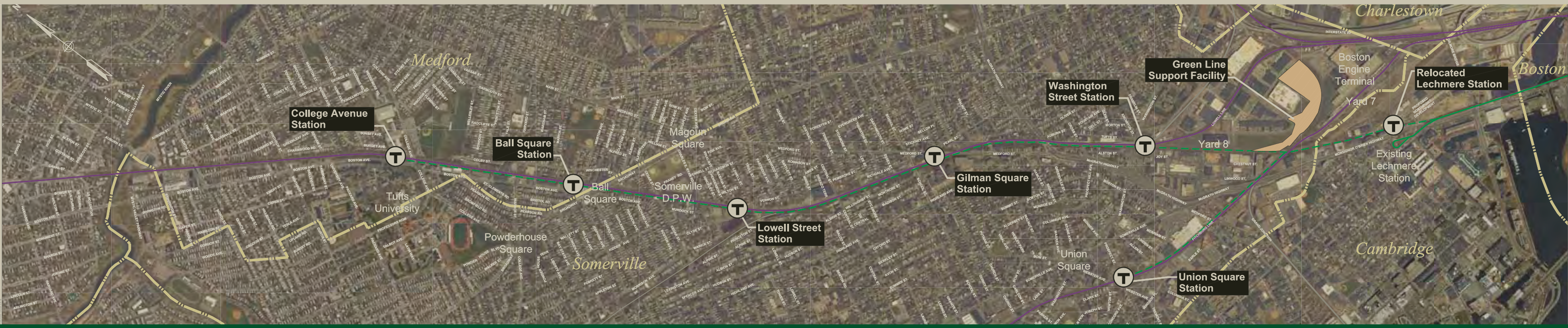


Environmental Assessment and Section 4(f) Evaluation

# Green Line Extension Project





## Volume 1 | Text

October 2011

GLX

Moving Massachusetts Forward. massDOT

U.S. Department of Transportation
Federal Transit Administration

# ENVIRONMENTAL ASSESSMENT (EA) AND SECTION 4(F) EVALUATION

*FOR THE*

**GREEN LINE EXTENSION PROJECT**

**CAMBRIDGE, SOMERVILLE AND MEDFORD, MASSACHUSETTS**

*by the*

**UNITED STATES DEPARTMENT OF TRANSPORTATION**
**FEDERAL TRANSIT ADMINISTRATION**

*and the*

**COMMONWEALTH OF MASSACHUSETTS**
**DEPARTMENT OF TRANSPORTATION**

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# Table of Contents

# List of Tables

# List of Figures

All figures are provided in Volume 2 except as indicated otherwise below.

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# Acronyms and Abbreviations

| | |
|---|---|
| **AAB** | Architectural Access Board |
| **AAI** | All Appropriate Inquiry |
| **ACO** | Administrative Consent Order |
| **ADA** | Americans with Disabilities Act |
| **ADT** | Annual Daily Traffic |
| **APC** | Automated Passenger Counter |
| **APE** | Area of Potential Effect |
| **APTA** | American Public Transportation Association |
| **ASI** | Automatic Station Identification |
| **ASME** | American Society of Mechanical Engineers |
| **ASTM** | American Society for Testing Materials |
| **AUL** | Activity and Use Limitation |
| **AVI** | Automated Vehicle Identification |
| **AVL** | Automated Vehicle Location |
| **BCIL** | Boston Center for Independent Living |
| **BLC** | Boston Landmarks Commission |
| **B&L** | Boston and Lowell Railroad |
| **B&M** | Boston and Maine Railroad |
| **BMPs** | Best Management Practices |
| **CAAA** | Clean Air Act Amendments |
| **CAD** | Computer-Assisted Dispatching |
| **CCTV** | Closed Circuit Television |
| **CEQ** | Council on Environmental Quality |
| **CERCLIS** | Comprehensive Environmental Response, Compensation and Liability Information System |

| | |
|---|---|
| **CFR** | Code of Federal Regulations |
| **CMR** | Code of Massachusetts Regulations |
| **CO** | Carbon monoxide |
| **$CO_2$** | Carbon dioxide |
| **CSO** | Combined sewer overflow |
| **CT2** | MBTA Cross Town Bus Route #2 |
| **CTPS** | Central Transportation Planning Staff |
| **DAV** | Disabled American Veterans |
| **dB** | Decibel |
| **dBA** | Hourly A-weighted equivalent sound level in decibels |
| **DC** | Direct current |
| **DCR** | Massachusetts Department of Conservation and Recreation |
| **DDT** | Dichlorodiphenyltrichloroethane |
| **DEIR** | Draft Environmental Impact Report |
| **DO** | Dissolved oxygen |
| **DOCs** | Diesel oxidation catalysts |
| **DOT** | United States Department of Transportation |
| **DPFs** | Diesel particulate filters |
| **EA** | Environmental Assessment |
| **ECPT** | East Cambridge Planning Team |
| **EDR** | Environmental Data Resources, Inc. |
| **EENF** | Expanded Environmental Notification Form |
| **EEA** | Executive Office of Energy and Environmental Affairs |
| **EOT or EOTPW** | (formerly) Executive Office of Transportation and Public Works |
| **EPA** | United States Environmental Protection Agency |
| **EPH** | Extractable petroleum hydrocarbons |
| **ERNS** | Emergency Response Notification System |
| **ESA** | Environmental Site Assessment |
| **FAQ** | Frequently Asked Question |

| | |
|---|---|
| **FAR** | Floor Area Ratio |
| **FEIR** | Final Environmental Impact Report |
| **FHWA** | Federal Highway Administration |
| **FONSI** | Finding of No Significant Impact |
| **FSC** | Forest Stewardship Council |
| **FTA** | Federal Transit Administration |
| **GHG** | Greenhouse Gas |
| **GPS** | Global Positioning System |
| **GLX** | Green Line Extension |
| **HCM** | Highway Capacity Manual |
| **HDPE** | High-density polyethylene |
| **HUD** | United States Department of Housing and Urban Development |
| **HVAC** | Heating, Ventilation and Air Conditioning |
| **Hz** | Hertz – noise cycles per second |
| **I** | Interstate |
| **I/M** | Inspection and Maintenance |
| **IRA** | Interim Remedial Action |
| **IRIS** | Integrated Risk Information System |
| **Kg/day** | Kilograms per day |
| **Ldn** | Day-night average sound level |
| **LED** | Light-emitting diode |
| **Leq** | Equivalent sound level |
| **Lmax** | Maximum noise level |
| **LNAPL** | Light non-aqueous phase liquid |
| **LPA** | Locally Preferred Alternative |
| **LOS** | Level of service |
| **LSP** | Licensed Site Professional |
| **LSTM** | Line source transfer mobility |
| **MAPC** | Metropolitan Area Planning Council |
| **MassDEP** | Massachusetts Department of Environmental Protection |

| | |
|---|---|
| **MassDOT** | Massachusetts Department of Transportation |
| **MassGIS** | Massachusetts Geographic Information System |
| **MBCR** | Massachusetts Bay Commuter Railroad Company |
| **MBTA** | Massachusetts Bay Transportation Authority |
| **MCP** | Massachusetts Contingency Plan |
| **MEPA** | Massachusetts Environmental Policy Act |
| **M.G.L.** | Massachusetts General Law |
| **MHC** | Massachusetts Historical Commission |
| **MIS/AA** | Major Investment Study/Alternatives Analysis |
| **MIT** | Massachusetts Institute of Technology |
| **MOA** | Memorandum of Agreement |
| **MPH** | Miles per hour |
| **MPO** | Metropolitan Planning Organization |
| **MRA** | Multiple Resource Area |
| **MRI** | Magnetic Resonance Imaging |
| **MSATs** | Mobile Source Air Toxics |
| **MSGP** | Multi-Sector General Permit |
| **MS4** | Small Municipal Separate Storm Sewer System |
| **MUTCD** | Manual on Uniform Traffic Control Devices |
| **MWRA** | Massachusetts Water Resource Authority |
| **$\mu g/m^3$** | micrograms per cubic meter |
| **NAAQS** | National Ambient Air Quality Standards |
| **NATA** | National Air Toxics Assessment |
| **NCHRP** | National Cooperative Highway Research Program |
| **NEPA** | National Environmental Policy Act |
| **NFPA** | National Fire Protection Association |
| **NHPA** | National Historic Preservation Act |
| **NLEV** | National Low Emission Vehicle Program |
| **NLR** | Noise level reduction |
| **NO** | Nitric oxide |

| | |
|---|---|
| **NOx** | Nitrogen oxide(s) |
| **$NO_2$** | Nitrogen dioxide |
| **NPDES** | National Pollutant Discharge Elimination System |
| **NPL** | National Priorities List |
| **NRSA** | Neighborhood Revitalization Strategy Area |
| **OCC** | Operations Control Center |
| **OCS** | Overhead contact system |
| **OHM** | Oil and hazardous materials |
| **OILR** | Outdoor-to-indoor level reduction |
| **OSHA** | Occupational Safety and Health Administration |
| **PAH** | Polycyclic aromatic hydrocarbons |
| **PAR** | Pan Am Railways |
| **PCB** | Polychlorinated biphenyls |
| **PCE** | Perchloroethylene |
| **PIP** | Public Involvement Plan |
| **PLOS** | Pedestrian Level of Service |
| **PM** | Particulate matter |
| **$PM_{10}$** | Particulate Matter of 10 microns and smaller |
| **$PM_{2.5}$** | Particulate Matter of 2.5 microns and smaller |
| **PMOC** | Project Management Oversight Consultant |
| **ppm** | parts per million |
| **PUD** | Planned Unit Development |
| **RAO** | Response Action Outcome |
| **RCRA** | Resource Conservation and Recovery Act |
| **REC** | Recognized Environmental Condition |
| **RFG** | Reformulated gasoline |
| **RMS** | Root-mean-square |
| **RTN** | Release Tracking Number |
| **RTP** | Regional Transportation Plan |
| **SCADA** | Supervisory Control and Data Acquisition |

| | |
|---|---|
| **SEL** | Sound exposure level |
| **SHPO** | State Historic Preservation Officer |
| **SIP** | State Implementation Plan |
| **SPCC** | Spill Prevention, Control, and Countermeasures |
| **ST** | Springfield Terminal Railway |
| **STIP** | State Transportation Implementation Program |
| **SVOC** | Semi-volatile Organic Compounds |
| **SWL** | Solid Waste Landfills |
| **SWPPP** | Stormwater Pollution Prevention Plan |
| **TAZ** | Transportation analysis zone |
| **TCLP** | Toxicity characteristic leaching procedure |
| **TCRP** | Transit Cooperative Research Program |
| **TIP** | Massachusetts Transportation Improvement Program |
| **TMDL** | Total Maximum Daily Load |
| **TOD** | Transit-oriented development |
| **TPH** | Total petroleum hydrocarbons |
| **TSD** | Treatment, Storage and Disposal |
| **TSM** | Transportation Systems Management |
| **TSS** | Total suspended solids |
| **U.S.** | United States |
| **USC** | United States Code |
| **UST** | Underground Storage Tank |
| **VdB** | Vibration decibels |
| **VDC** | Volts direct current |
| **V/C** | Volume to capacity ratio |
| **VOC** | Volatile organic compounds |
| **VMT** | Vehicle miles traveled |
| **VPH** | Volatile petroleum hydrocarbons |
| **WAN** | Wide Area Network |
| **YOE** | Year-of-Expenditure |

# Executive Summary

Comments on this Environmental Assessment (EA) and Section 4(f) Evaluation may be submitted in writing to:

Katherine S. Fichter
MassDOT Office of Transportation Planning
10 Park Plaza, Room 4150
Boston, MA 02116

Comments must be received by **November 18, 2011**. Comment letters may also be submitted by fax to Katherine Fichter at (617) 973-8035, TTY (617) 973-7306, or by email to katherine.fichter@state.ma.us.

A public hearing will be held to discuss the EA and provide opportunity for members of the public and other stakeholders to provide comments. The meeting will be held on:

October 20, 2011 at 6:30 PM
Somerville High School – Auditorium
81 Highland Avenue, Somerville, MA 02143

If you need this document in alternative languages or formats, please contact Regan Checchio at (617) 357-5772, or by email to rchecchio@reginavilla.com.

## About the Project

The Green Line Extension project is an initiative of the Massachusetts Department of Transportation (MassDOT) and the Massachusetts Bay Transportation Authority (MBTA) to improve corridor mobility, boost transit ridership, improve air quality, ensure equitable distribution of transit services, and support opportunities for smart growth initiatives and sustainable development in the project study area of Cambridge, Somerville, and Medford. The project is required by the State Implementation Plan (SIP) and fulfills a longstanding commitment of the Central Artery/Tunnel project to increase public transit. The Green Line Extension is expected to open for service in June 2019 and would cost $971 million, plus finance charges, in 2011 dollars to construct. "Year-of-Expenditure" (YOE) capital costs for the Proposed Action would be approximately $1.1 billion, plus finance charges, in YOE dollars. The Green Line Extension project requires review under the National Environmental Policy Act (NEPA) in order to use Federal funding. The Federal Transit Administration (FTA) has agreed to serve as the lead federal agency for the project for the NEPA review.

The Green Line Extension project would provide light rail transit beyond Cambridge's Lechmere Station, which is currently the only Green Line station north of the Charles River. The Proposed Action would serve the region's most densely populated communities that today are surrounded by, but are not directly served by, fixed-guideway transit. The residential densities are approximately 18,870 people per square mile in Somerville, 15,760 in Cambridge, and 6,850 in Medford.[1] Somerville is recognized as one of the most densely populated municipalities in the United States. In addition, approximately 60 percent of the residents of Cambridge, Somerville, and Medford live in state-defined environmental justice areas, which take up approximately 42.8 percent of the cities' combined area.[2]

Although MBTA commuter rail lines pass through the project study area, there are no rail transit stops within these communities. The project study area is currently served by bus transit only, and U.S. Census data (2000) indicates that approximately 26 percent of project study area households do not own a vehicle, which suggests a market for a higher level of transit service than exists today. Existing transit service within the project study area is currently offered by 15 MBTA bus routes with access to points within the project study area as well as to Boston, Arlington, Woburn, and Winchester. However, existing bus routes operate within the congested urban street network where intense automobile traffic hinders bus service and causes inefficient and unreliable transit service in the project study area.

The Green Line Extension project is needed to improve corridor mobility and livability, particularly in transit-dependent and environmental justice populations. The Green Line Extension project enjoys community support throughout the corridor, where residents and businesses want better and expanded transportation access.

The Green Line Extension project offers benefits to the area, in that the Proposed Action would:

- Focus regional transportation investment in established environmental justice populations, connecting currently underserved residents to jobs and services in Boston and Cambridge and strengthening business and residential districts in the corridor.
- Improve transit travel times within the project study area by 13 to 17 minutes (compared to the No-Build Alternative) from the relocated Lechmere Station to Union Square or College Avenue, respectively.
- Offer a one-seat ride from the project study area into downtown Boston, eliminating the need for commuters to make the bus/rail transfer to the Green Line at the relocated Lechmere Station or to the MBTA Orange and Red Lines at other stations.

1 United States Census Bureau, *Census 2000*. Available at http://www.census.gov.
2 Environmental justice areas are defined by thresholds for income, minority populations, foreign-born populations, and English language proficiency. Therefore, most environmental justice areas contain a mix of environmental justice and non-environmental justice residents.

- Generate daily ridership at the project's seven stations of approximately 49,000 boardings and alightings by 2030, with approximately 92 percent of the new ridership is projected to take place in the project's opening year. The Green Line as a whole would also see an increase of 25,970 boardings, and the entire MBTA system would see an increase of 7,500 new daily linked transit trips as a result of the extended Green Line service.
- Substantially improve mobility and service quality for transit-dependent riders, with improved access (*i.e.*, service, travel time savings) to jobs or schools and health care facilities and provide universal access, meeting Americans with Disabilities Act (ADA) standards at all stations.
- Be fully grade separated and principally constructed within existing MBTA rail rights-of-way, which would enable light rail to serve pedestrian-oriented centers with minimal disruption to the surrounding community and with minimal property or neighborhood impacts.
- Maintain existing railroad operations while employing mitigation measures to reduce noise and vibration impacts, resulting in residential and retail areas that would experience reduced existing noise levels.
- Reduce daily vehicle miles traveled (VMT) by 25,728, as compared to the No-Build Alternative, improving regional air quality and providing zero-emission transportation capacity for anticipated growth.

## The Proposed Action

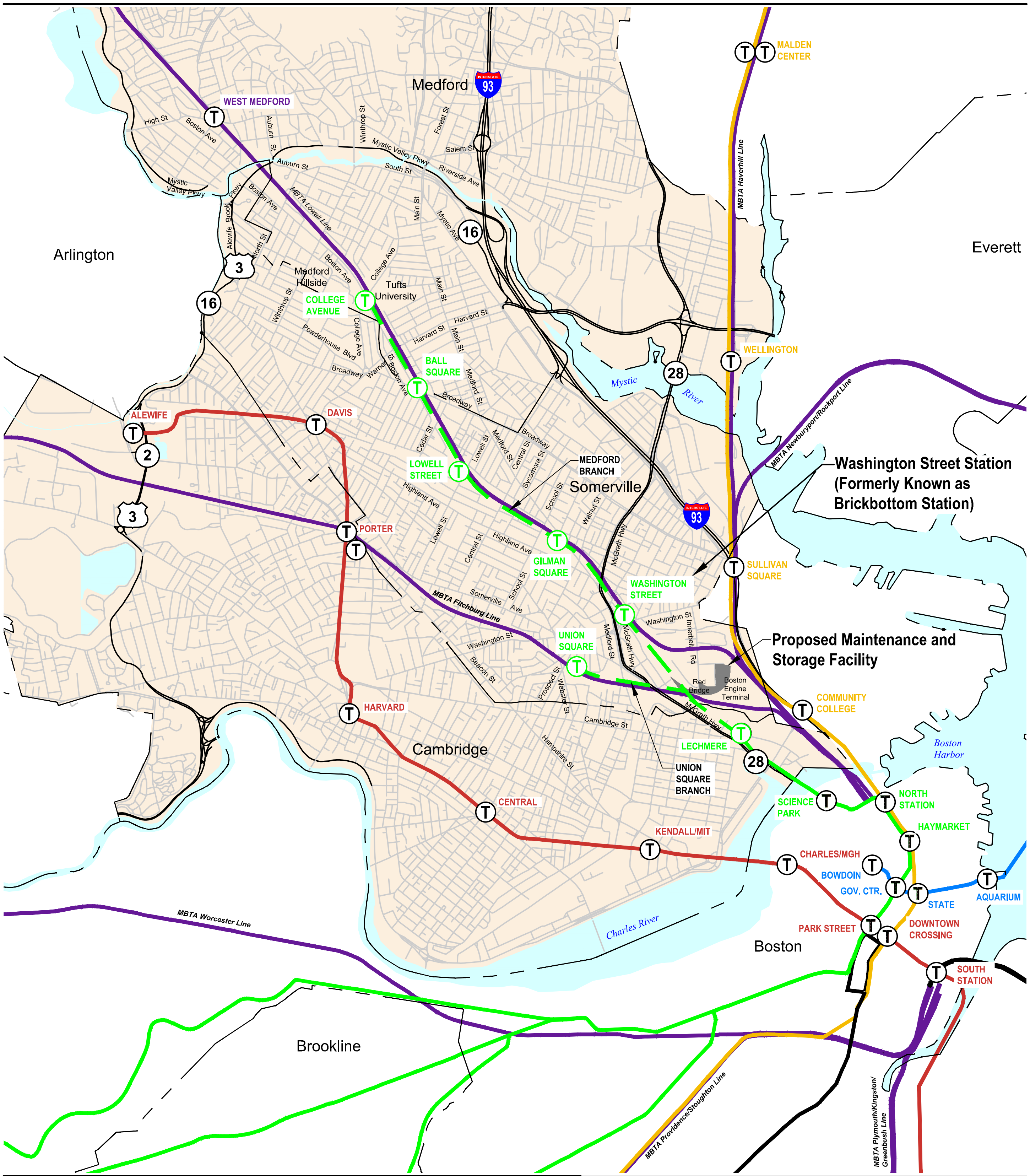
The Proposed Action, as shown on Figure ES-1 and evaluated in this Environmental Assessment (EA), includes:

- Extending Green Line service 3.4 miles north to Medford (the Medford Branch) within the existing MBTA Lowell Line commuter rail right-of-way, from a relocated Lechmere Station to College Avenue Station with intermediate stations at Washington Street, Lowell Street, Gilman Square, and Ball Square; and
- Extending Green Line service 0.9 miles west to Union Square (the Union Square Branch) in Somerville, within the existing MBTA Fitchburg Line commuter rail right-of-way, from the relocated Lechmere Station to a new station near Union Square.

A detailed analysis of potential alternative alignments, station sites, and environmental impacts was performed and documented in a Draft Environmental Impact Report/ Environmental Assessment (DEIR/EA) in October 2009. As a result of this analysis, the Proposed Action was selected for its ability to: meet all of the project goals; provide the best balance of cost, ridership, and environmental impacts; be operationally practical; and generate a high number of new systemwide transit trips.

Since the issuance of the DEIR/EA, a number of items have been updated as the conceptual engineering has advanced and additional analysis has been performed. Items that have been revised include:

- **Noise and Vibration** –Additional noise and vibration analyses were conducted and specific mitigation measures identified. The additional noise and vibration analysis was prepared in accordance with FTA guidelines and is presented in Sections 6.7, *Noise*, and 6.8, *Vibration*, and in Appendix F, *Noise and Vibration Technical Report*, of this EA. Additionally, tracks in the vicinity of the Brickbottom Artists building have been relocated farther from the northeast building façade in order to minimize noise impacts in this vicinity.
- **Stations** – Working with the public, local municipalities, and project stakeholders, the proposed station locations and designs were further refined. As described in Section 4.4.4, *Stations*, of this EA, the refinements to station designs include:
  - Modifications at the relocated Lechmere Station including refinements to the station layout, busway and roadway improvements, and pedestrian access improvements;
  - Relocation of Washington Street Station (formerly Brickbottom Station) to a location closer to Washington Street for better neighborhood access and to minimize property acquisitions; and
  - Refining the conceptual designs at the stations to provide pickup/drop-off locations, as well as emergency egress.
- **Maintenance Facility** – Additional alternatives were further evaluated for the proposed maintenance and storage facility required to support the Green Line Extension project. To address and resolve public concerns that were raised following the selection of the Yard 8 site, MassDOT quantitatively analyzed two additional potential sites for the facility – Option L and Mirror H. The Option L site was selected as the preferred location for the maintenance and storage facility in late 2009, was further studied in early 2010, and is described in Section 4.4.5, *Maintenance and Storage Facility*, of this EA.
- **Ridership** – The statewide transportation model, maintained by the Boston Region Metropolitan Planning Organization's Central Transportation Planning Staff (CTPS), was updated with 2009 systemwide passenger survey results and a revised list of programmed future regional projects.

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**Green Line Extension Project**

**Figure ES-1**

Proposed Action

*Legend*

- *MBTA Green Line*
- *MBTA Orange Line*
- *MBTA Red Line*
- *MBTA Blue Line*
- *MBTA Silver Line*
- *MBTA Commuter Rail Line*
- *Green Line Proposed Action*
- *Proposed Station*
- *Proposed Maintenance Facility*

0 2000 4000 Feet

- **Historic/Archeological Resources –** Correspondence with the Massachusetts Historical Commission (MHC) began in 2008. Section 106 of the National Historic Preservation Act[3] (NHPA) and Section 4(f) of the U.S. Department of Transportation Act of 1966[4] consultation sessions were held in December 2010 with the MHC and the local historical commissions to discuss any Section 106 properties and Section 4(f) properties that would be affected by the project. Based on the meetings, additional historic resources were identified and analyzed. A consultation session was offered to interested Tribal Nations to discuss potential archeologically sensitive resources. Additional information on the Section 106 process is provided in Section 2.6.3, *Section 106Consultation Sessions;* Section 5.15, *Cultural Resources;* and Section 6.13, *Cultural Resources,* of this EA. Additional information on the Section 4(f) process is provided in Section 6.11, *Parks and Recreation Areas,* and Chapter 8, *Section 4(f) Evaluation,* of this EA.

The engineering and environmental analyses have been revised, where appropriate, to reflect the changes described above. The environmental impacts of the Proposed Action have been fully evaluated and are described in detail in this EA.

## About the NEPA Process

The Green Line Extension project requires review under the NEPA in order to use Federal funding. The Council on Environmental Quality (CEQ) Regulations for Implementing NEPA ensure that information on the social and environmental impacts of any Federally funded action is available to public officials and citizens before decisions are made and before actions are taken.[5]

NEPA regulations direct Federal agencies to integrate into their planning and decision-making the natural and social sciences, environmental amenities and values, and the design arts along with the necessary engineering and economic considerations.[6] The objective is to balance infrastructure development, economic prosperity, health and environmental protection, community and neighborhood preservation, and quality of life. Based on the current assessment of project impacts, a Finding of No Significant Impact (FONSI) is anticipated for the Green Line Extension project. However, a Public Hearing will be held and comments on this EA will be addressed and considered prior to a final decision.

In addition to environmental review under NEPA, the project also required preparation and review of an October 2009 DEIR and a June 2010 Final Environmental Impact Report (FEIR) under the Massachusetts Environmental Policy Act (MEPA). Following

3 Section 106 of The National Historic Preservation Act of 1966, as amended through 2006.
4 Section 4(f) of the United States Department of Transportation Act of 1966 (Amended March 12, 2008 in 73 FR 13395; implemented at 23 U.S.C. 138 and recodified at 49 United States Code, Subtitle I, Section 303(c). Available at: http://www.gpo.gov/fdsys/pkg/FR-2008-03-12/pdf/E8-4596.pdf
5 Executive Office of the President, Council on Environmental Quality, *Regulations for Implementing the Procedural Provisions of the National Environmental Policy Act* (40 CFR Parts 1500 - 1508).
6 United States Department of Transportation, Federal Transit Administration and Federal Highway Administration, *Environmental Impact and Related Procedures* (23 CFR Part 771). Available at: http://www.fta.dot.gov/

public review of the FEIR, the Secretary of the Executive Office of Energy and Environmental Affairs (EEA) issued a final Certificate on July 30, 2010 stating that the Green Line Extension project adequately and properly complies with MEPA and its implementing regulations, and can proceed with state and local permitting.[7]

## Public Involvement

The Green Line Extension project has received considerable public input throughout the planning process. Hundreds of comment letters on project documents and community participation in public hearings and workshops reflect a substantial interest in the future of the corridor from elected officials and municipal representatives; city, state, and regional agencies; environmental, bicycle, and pedestrian advocacy groups; neighborhood groups; groups that represent the disabled; businesses; residents; and the general public.

To plan and develop the Green Line Extension project in coordination with this wide range of interests, MassDOT established a public involvement process that included an Advisory Group, open public meetings, station workshops, and coordination with the staff and elected officials of Cambridge, Somerville, and Medford, as well as other stakeholders and neighborhood interest groups within the project study area. The project team has also provided documents summarizing project meetings, activities, and information on a regular basis. The team reached out to environmental justice and disabled populations within the community to ensure their participation in the NEPA process. In addition to numerous public meetings, a public hearing was held after publication of the DEIR/EA, and a public meeting was held after the FEIR was released. A Design Working Group has been established to participate in advancing the conceptual engineering elements. Most recently, a Public Involvement Plan (PIP) has been developed for use during the design and construction phases of the project.

MassDOT has maintained an interactive project website, www.mass.gov/greenlineextension. Along with a brief overview of the project's history and current phase, the website provides access to various reference materials, including documents from previous phases of the project as well as the most up-to-date project materials. Interested individuals are able to sign up to be part of the project mailing list. Individuals are also able to post comments about the project publicly, as well as use the website to ask questions of MassDOT and the project team.

Regular coordination with the officials of Cambridge, Somerville, and Medford has occurred throughout the project. In addition to the outreach at a local level, there was also a large amount of coordination with the various state and Federal agencies to discuss potential project impacts and other project details. Agency coordination

7 Commonwealth of Massachusetts, Executive Office of Energy and Environmental Affairs. *Green Line Extension - Certificate of the Secretary of Energy and Environmental Affairs on the Final Environmental Impact Report*, July 30, 2010. Available at: www.mass.gov/greenlineextension

included, but was not limited to, the FTA, the MBTA, MassDOT, Massachusetts Department of Environmental Protection (MassDEP), the Massachusetts Department of Conservation and Recreation (DCR), the Metropolitan Area Planning Council (MAPC), the MHC, and CTPS. Additional information on public involvement is included in Chapter 2, *Public Involvement and Agency Coordination*, of this EA.

## What Alternatives did MassDOT/FTA Evaluate?

Six "Build" Alternatives, a No-Build Alternative, and a Baseline Alternative were evaluated in the DEIR/EA, published in October 2009. The Baseline Alternative was evaluated to identify the best option for meeting the transportation needs of the project study area with smaller capital investments than were estimated for the Build Alternatives. The Baseline Alternative evaluated in this EA includes enhanced bus service within the project study area, including expanding the existing MBTA Route 80 service between Lechmere Station and the proposed Build Alternatives' College Avenue Station site, and providing a new shuttle bus service between Lechmere Station and Union Square. The six Build Alternatives that were evaluated in the DEIR/EA, summarized in Table ES-1, were based on two alternative termini for the Medford Branch and two alternative alignment locations for the Union Square Branch.

### Table ES-1 Comparison of DEIR/EA Build Alternatives

| Alternative | Medford Branch Terminus Alternatives | Union Square Branch Alignment Locations | Daily Boardings (2030)[1] | Capital Cost ($M)[2] |
|---|---|---|---|---|
| 1 | College Ave | Commuter Rail Right-of-Way | 7,500 | $804.8 |
| 2 | Mystic Valley Parkway/ Route 16 | Commuter Rail Right-of-Way | 8,900[3] | $959.3 |
| 3 | College Ave | In-street | 7,700 | $829.8 |
| 4 | Mystic Valley Parkway/ Route 16 | In-street | 8,700 | $984.3 |
| 5 | Mystic Valley Parkway/ Route 16 | N/A | 10,500 | $870.0 |
| 6 | N/A | Commuter Rail Right-of-Way | 3,900 | $370.6 |

1 Additional systemwide daily boardings, as compared to the No-Build Alternative.
2 2008 dollars.
3 These results included 300 parking spaces at Mystic Valley Parkway/Route 16 Station. With no parking at this station, the ridership would be 8,600 new systemwide boardings daily, and the capital cost would be $951.8 million.

This EA provides further evaluation of the DEIR/EA's Locally Preferred Alternative (LPA), Alternative 1, and additional information on alternatives evaluated is included in Chapter 4, *Alternatives*, of this EA.

## Project Description

The Proposed Action would provide service to College Avenue in Medford and Union Square in Somerville using a two-branch operation, both primarily within existing commuter rail rights-of-way. The primary infrastructure improvements include relocating existing commuter rail lines; constructing approximately 4.3 miles of new light rail track and ancillary systems, four multi-span viaducts, seven new stations, a vehicle maintenance and storage facility; and reconstructing 11 bridge structures to support the extended service. An additional 24 Green Line cars would be needed to accommodate the proposed headways (time between each train) and projected ridership for the project. Based on current MBTA subway fares, fares for the Green Line Medford Branch and Union Square Branch would be $1.70 for one-way adult trips using a Charlie Card. Further description of the operating plan for each branch is included in the following sections.

### Medford Branch

The 3.4-mile long Medford Branch would operate from a relocated Lechmere Station to College Avenue in Medford within the MBTA Lowell Line commuter rail right-of-way. This branch would begin at relocated Lechmere Station and head northwest, meeting the MBTA Lowell Line just south of Washington Street in Somerville. From Washington Street, the alignment would run parallel to the MBTA Lowell Line to Medford, terminating at College Avenue in Medford.

Estimated travel time between College Avenue Station and the relocated Lechmere Station for the proposed Green Line Medford Branch is 9.5 minutes. Green Line service for the Medford Branch would operate on headways equal to that of the existing Green Line D branch service: 5 minutes in the morning and evening peak periods and 10 minutes during off-peak periods.

The Medford Branch would be constructed within the existing MBTA Lowell Line right-of-way, owned by the MBTA. The existing commuter rail tracks would be shifted approximately 13 feet toward the east side of the right-of-way. The new light rail track and overhead contact system (OCS) (electric power supply) would be added within the western half of the right-of-way. Most of the right-of-way is located below the surrounding land surface, reducing environmental impacts such as increases in noise levels and changes to the visual environment. Retaining walls would be used where necessary to eliminate the need to acquire adjacent property.

Although the Medford Branch would be constructed within the existing MBTA right-of-way, 10 existing roadway and rail bridges would need to be reconstructed to accommodate the new light rail tracks. These include:

- Somerville:
  - Former Red Bridge (rail)
  - Washington Street (rail)
  - Walnut Street (roadway)
  - Medford Street (roadway)
  - School Street (roadway)
  - Lowell Street (roadway)
  - Cedar Street (roadway)
  - Broadway (roadway)
- Medford:
  - Harvard Street (rail)
  - College Avenue (roadway)
- The Lechmere Viaduct over Monsignor O'Brien Highway/Route 28 in Cambridge would be replaced by a new light rail viaduct paralleling the highway on its north side and incorporating the relocated Lechmere Station.

## Union Square Branch

The 0.9-mile long Union Square Branch would also originate at the relocated Lechmere Station and head northwest to Red Bridge, then follow the MBTA Fitchburg Line commuter rail right-of-way to the Union Square area. The Union Square Branch would be constructed within the existing MBTA Fitchburg Line right-of-way. The existing commuter rail tracks would be shifted approximately 10 to 14 feet toward the south side of the right-of-way. The new light rail track and OCS would be added within the northern half of the right-of-way. Most of the right-of-way is located below the surrounding land surface, reducing environmental impacts such as increases in noise levels and changes to the visual environment. Retaining walls would be used where necessary to eliminate the need to acquire adjacent property. The Union Square Branch would require reconstructing the Medford Street rail bridge in Somerville. Two new viaducts would be needed at Red Bridge Junction to serve the Union Square Branch.

Estimated travel time between Union Square and relocated Lechmere Station for the proposed Green Line Union Square Branch is 4.5 minutes. Green Line service for the Union Square Branch would operate on headways equal to that of the existing Green Line E branch service: 6 minutes in the morning peak period, 5 minutes in the evening peak period, and between 9 and 10 minutes during off-peak periods.

## Construction

Construction staging and sequencing strategies are critical to achieving the balance of an efficient construction project while minimizing the impacts to vehicular traffic, pedestrian traffic, on-street parking, public access, and emergency access in local communities. The surrounding project area presents several construction challenges including narrow roadways, urban traffic volumes, and a variety of commercial, industrial, and residential land uses that require continuous access, and offer limited space for construction zones and lay down areas within or near the rail corridor. Existing rail service must be maintained during construction. The preliminary analysis of construction staging and sequencing shows that it is feasible to construct the project while maintaining railroad operations, access to abutters, and traffic and pedestrian paths. A comprehensive construction staging and sequencing plan would be developed and included in the final construction contract documents and communicated to the public.

The use of the existing MBTA commuter rail right-of-way for the proposed Green Line tracks greatly reduces the complexity of construction as well as construction impacts. The existing right-of-way ranges from 55 to 110 feet in width. In places where space is limited by steep slopes, retaining walls have been proposed to maximize usable space in the railroad rights-of-way. Figures ES-2 and ES-3 show cross-sections of the existing and proposed rights-of-way, respectively, along the Medford Branch.

Figure ES-2 Existing Section along Medford Branch Looking North

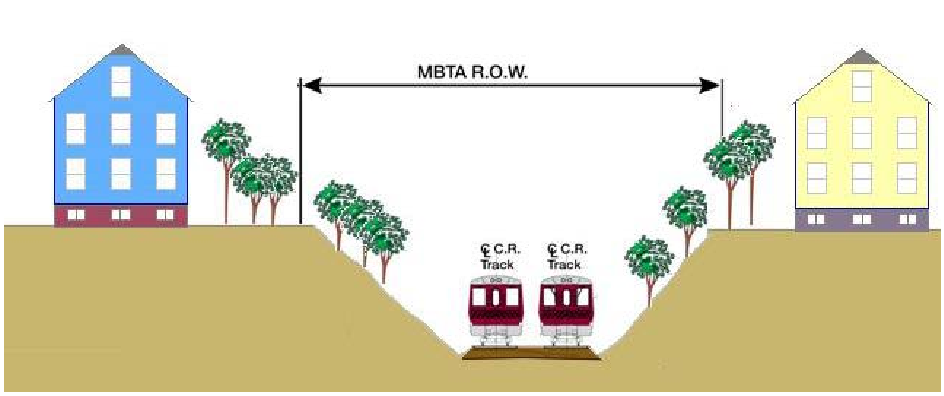
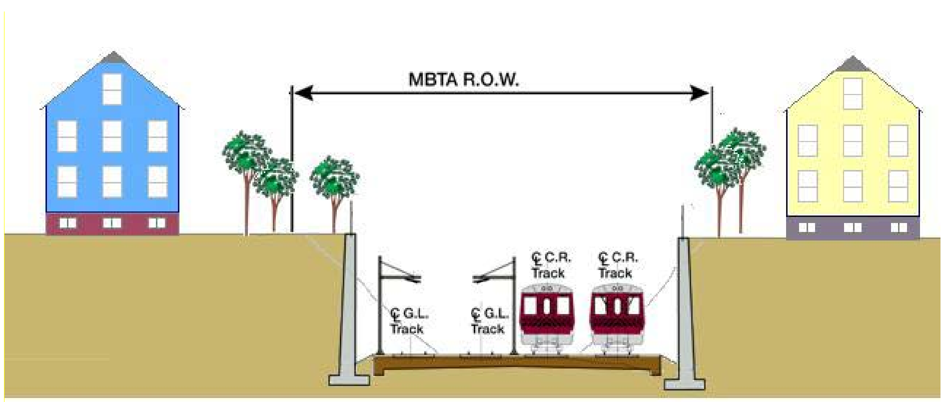



Figure ES-3 Proposed Section along Medford Branch Looking North



Bridge reconstruction would be staged whenever possible to maintain traffic and access to businesses over the bridges during construction. Construction staging would be required for roadway traffic as well as rail traffic beneath the bridge. In some cases staged construction is not feasible and the bridge would have to be closed during construction. The project would limit bridge closures such that no two consecutive bridges would be closed at the same time. Detour plans would be developed in coordination with MassDOT and the affected cities.

Construction procedures would comply with MassDEP's solid waste and air quality control regulations to control contaminated soils and protect air quality during construction.

## Stations

Station locations for the project were identified through an evaluation process and working with the public and local officials. Important considerations in station siting and configuration included operations, access, and impacts to nearby properties. Stations are intended to function as neighborhood stations with no provisions for new parking, except for at the relocated Lechmere Station.

For the Medford Branch, the existing Lechmere Station would be relocated, and five new stations would be constructed at:

- Washington Street;
- Gilman Square;
- Lowell Street;
- Ball Square; and
- College Avenue.

For the Union Square Branch, a new station would be constructed along the rail corridor at Prospect Street near Union Square.

Stations were designed to meet the project's goals of improved transit access and accessibility, and to minimize impacts to the community associated with land acquisition, traffic, and loss of parking. Each station would provide designated pickup/drop-off areas, a headhouse with automated fare lines, vending machines, an information booth, and restrooms. Figures ES-4 and ES-5 show a typical station layout and elevation, respectively. All stations would incorporate sustainable design principles to the extent practical.

The design of each platform was based on projected peak hour passenger volume at each station. Station designs also took into account access to nearby bus connections. Station access and platform design were based on requirements and guidance provided by the ADA (1990) standards and the Commonwealth of Massachusetts Architectural Access Board (AAB), as well as requirements of the MBTA. Many station platforms would be located at a different elevation than the ground-level station access points. Entry to and exit from the platforms would be by elevators, escalators, and stairs.

Figure ES-4 Typical Station Layout

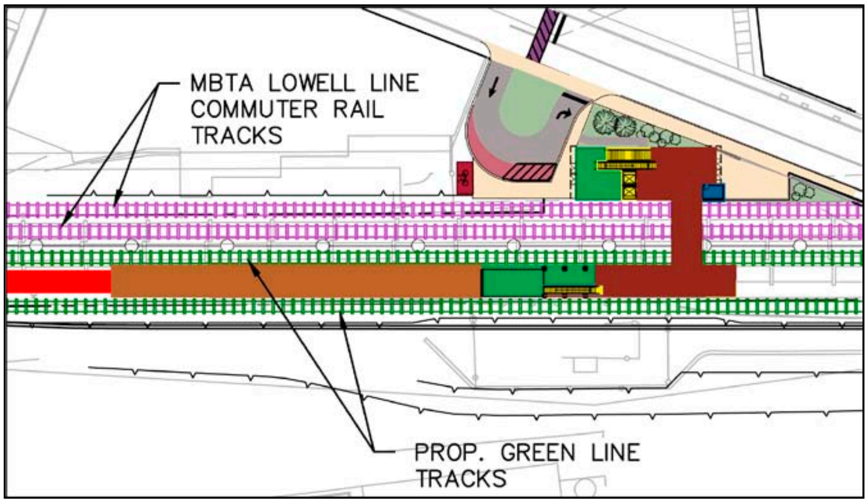
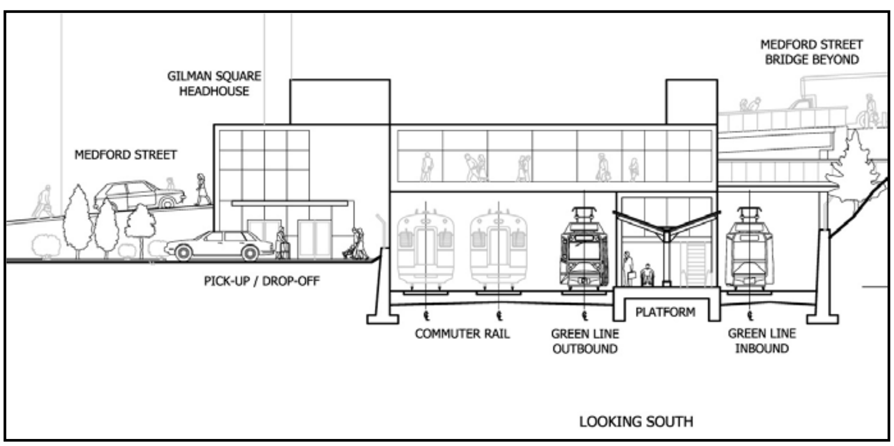



Figure ES-5 Typical Station Elevation



## Maintenance and Storage Facility

There are currently no maintenance or storage facilities located on the north side of the MBTA light rail system in the proximity of the Green Line Extension project. The Proposed Action requires a new maintenance and storage facility on the north side of the Green Line system to store, inspect, maintain, and repair cars and to provide a base for the maintenance and repair of the track, power, and signal systems. An extensive and comprehensive evaluation of potential maintenance and storage facility sites was conducted. Numerous sites were considered for the new facility including the MBTA Boston Engine Terminal commuter rail maintenance facility and the site alternatives referred to in this analysis as Yard 8, Mirror H, and Option L. Since the issuance of the DEIR/EA, the Option L site has been selected as the preferred maintenance and storage facility location, since it would provide the best balance of operational and environmental benefits and impacts and would be most compatible with the long-term planning goals of local communities.

The Option L site is located immediately adjacent to and northwest of the MBTA Boston Engine Terminal, along the southern and southeastern fringe of the existing Inner Belt industrial area of Somerville. The maintenance building and associated trackwork are proposed on land adjacent to and northwest of the MBTA Boston Engine Terminal. The land is currently occupied by two businesses at 20 Third Avenue and 44-48 Third Avenue. Full acquisition of these parcels would be required. The maintenance building and east storage yard is proposed at the southern end of Inner Belt Road, just north of the MBTA Fitchburg Line, which is currently an unused parking lot for 70 Inner Belt Road and the undeveloped southern corner of 200 Inner Belt Road.

## Estimated Cost

During the development of the DEIR/EA, 10 percent design concept plans for the Proposed Action and detailed capital cost estimates were developed. The capital improvements include, but are not limited to, construction of track, stations, structures, systems, drainage, utilities, and the maintenance facility. Additional costs include property acquisitions and business relocations as well as vehicle acquisition and professional services. The cost of the Proposed Action includes the cost to relocate Lechmere Station. The overall cost of the Proposed Action is currently estimated to be approximately $971 million plus finance charges in 2011 dollars, including $82 million for 24 additional Green Line vehicles. Annual operating and maintenance costs would be approximately $24.5 million in 2011 dollars. The total costs for the Proposed Action were further refined to include inflation for the time period in which the project is to be implemented (2019). YOE capital costs for the Proposed Action were calculated to be approximately $1.1 billion, plus finance charges, in YOE dollars.

## Somerville Community Path

The Somerville Community Path currently travels through the Davis Square area of Somerville and connects with other elements of the regional multi-use path system in Cambridge, Belmont, and Arlington. A proposed extension of the Somerville Community Path would create a new connection of the Path from its anticipated terminus at Lowell Street in Somerville to the Inner Belt area (also in Somerville), with potential connections to East Cambridge and Boston. In general terms, the proposed route follows the edge of the MBTA Lowell Line, generally located at street level, while the existing heavy rail and proposed Green Line trains would run below grade, in a cut section.

As part of its commitment to the Somerville community, MassDOT has agreed to complete all planning, design, and engineering work - including the identification of necessary property acquisitions - for the proposed extension of the Somerville Community Path between Lowell Street and Inner Belt Road. However, the City of Somerville remains the chief proponent for the extension of the Community Path. Wherever possible, MassDOT would design the extension of the Community Path in such a way that direct connections can be made from the Community Path extension into the unpaid area of Green Line Extension stations.

The Green Line Extension project and the Somerville Community Path are separate and distinct projects, with their own project-development trajectories and timelines.

# What are the Proposed Action's Benefits and Impacts?

This EA evaluates the Proposed Action's impacts – both beneficial and adverse – on natural and human resources. These impacts were compared to the effects of the No-Build Alternative, in the year 2030. The Proposed Green Line Extension project offers benefits with minimal impact to the project study area by virtue of the fact that it would be constructed within existing MBTA rail rights-of-way, which would enable light rail service to serve pedestrian-oriented centers with minimal disruption to the surrounding community and without considerable property acquisitions or neighborhood impacts.  Benefits and adverse impacts of the Proposed Action include:

- **Land Use, Social and Economic Resources** – The Proposed Action is expected to decrease low intensity commercial and light industrial uses in the project study area and increase mixed-use, high-density transit-oriented development, particularly at Union Square Station and Ball Square Station. The Proposed Action would increase transit access for the local communities, which increases both the potential for local commerce and the potential for area residents to commute to jobs elsewhere. Approximately 15.2 acres of land from 40 properties is required for the Proposed Action (including four parcels totaling 10.2 acres for the proposed maintenance and storage facility). The displacement and relocation of four active businesses would be required; however, no residences would be displaced. Property acquisitions would reduce annual property tax revenue by $7,099 in Cambridge, $17,945 in Medford, and $420,188 in Somerville. A total of 204 jobs would be displaced or relocated, the majority of which (194 jobs) are currently held in Somerville. All property acquisitions and relocations will be conducted in compliance with the Uniform Relocation Act.[8] Additional information is included in Section 6.2, *Land Use*, and Section 6.3, *Socioeconomic Impacts*, of this EA.

- **Environmental Justice** – There would be no disproportionate impacts to environmental justice populations from the Proposed Action. The Proposed Action would increase transit access to jobs, colleges, and health care for environmental justice and disability populations. Access for environmental justice populations would improve approximately 3.7 to 4.8 percent for employment opportunities, approximately 9.3 percent to colleges, and approximately 1.5 percent to hospitals. Access for disability populations would improve approximately 6 to 7 percent for employment opportunities, approximately 15.5 percent to colleges, and approximately 2.5 percent to hospital beds. Regional transportation investment funds would be focused on established environmental justice populations, connecting residents to jobs and services in Boston and Cambridge and strengthening business and residential districts in the project study area. Additional information is included in Section 6.4, *Environmental Justice*, of this EA.

- **Traffic** – The Proposed Action would not have an adverse impact on traffic operations in the project study area. The Proposed Action would provide roadway and signal modifications at 12 intersections to prevent adverse traffic impacts from the project. The Proposed Action would provide pedestrian improvements at 29 locations to improve pedestrian flow and safety. Future connections from bicycle routes directly to the proposed stations would be possible. Bicycle parking would be provided to accommodate and encourage commuting by bicycle. Fewer than 12 parking spaces would be permanently impacted on Boston Avenue near Winthrop Street. Temporary lane closures, traffic detours, and displacement of on-street parking in some locations could occur during construction. Additional information is included in Section 6.5, *Traffic and Transportation Systems*, of this EA.

8 United States Department of Transportation. 49 CFR Part 24, *Uniform Relocation Assistance and Real Property Acquisition Policies Act of 1970*, as amended. Public Law 91-646, January 2, 1971. Available at: http://www.fhwa.dot.gov/realestate/ua/uraguide3805.pdf

- **Air Quality –** The Proposed Action would provide important air quality benefits and would fulfill a longstanding commitment to incorporate transit projects as an integral element of the Central Artery/Tunnel project. The Proposed Action would reduce daily VMT by 25,728, improving air quality and providing zero-emission transportation capacity for anticipated growth. The proposed Green Line Extension project complies with the Clean Air Act Amendments (CAAA). Additional information is included in Section 6.6, *Air Quality,* of this EA.

- **Noise –** Although the Proposed Action would introduce a new noise source into the project study area, proposed noise barriers, potential sound insulation, and rail lubrication would be effective in mitigating potential noise increases. Without mitigation, 152 noise-sensitive receptors would be exposed to noise increases including 108 moderate impacts and 40 severe impacts at single-family and multi-family residential buildings, moderate impact at Tufts University Science and Technology Center and Outside the Line Artist's Studio (a teaching facility), moderate impact at Trum Playground, severe impact at the Walnut Street Center (a non-profit support center for adults with developmental disabilities) near Union Square and ground-borne noise impact at Tufts Bacon Hall and Tufts Curtis Hall. For locations along the existing commuter rail lines, the future noise levels are expected to be substantially lower than the existing noise levels due to the noise barriers. Temporary noise impacts could result from construction activities. Additional information is included in Section 6.7, *Noise,* of this EA.

- **Vibration –** The proposed vibration mitigation for the proposed Green Line Extension project would keep vibration levels at or below existing levels for commuter trains and reduce vibration from Green Line trains below the FTA's impact criteria. Proposed mitigation includes ballast mats, resiliently supported ties or resilient rail fasteners on the proposed Green Line tracks and the relocated commuter rail tracks, and relocation or use of specially engineered trackwork. Without mitigation, 88 vibration-sensitive receptors would be exposed to vibration impact including 83 single-family or multi-family residential properties and the Science and Technology Center, Bacon Hall, Bray Labs, and Curtis Hall at Tufts University, and Outside the Line Artist Studio. Additional information is included in Section 6.8, *Vibration,* of this EA.

- **Stormwater –** The Proposed Action would result in an overall decrease of 1.2 acres of impervious area as compared to the No-Build Alternative. This reduction is accomplished mainly by removing existing structures and impervious parking areas and replacing them with areas of new track and ballast for the construction of the maintenance and storage facility. Following construction of the facility, approximately 40 percent (3.4 acres) of the impervious area would be roof tops, which are expected to generate clean runoff except for airborne deposits. Stormwater Best Management Practices (BMPs) would be used during construction to minimize impacts from construction activities. Additional information is included in Section 6.9, *Stormwater,* of this EA.

- **Fish, Wildlife and Plants –** The Proposed Action would not have an adverse effect on fish, wildlife, or plants. There are no Federal or state-listed endangered or threatened species present within the project study corridor. Additional information is included in Section 6.10, *Fish, Wildlife, and Plants*, of this EA.

- **Wetlands –** There are no Federal- or state-regulated wetlands within the project study corridor.

- **Parks and Recreation Areas –** The Proposed Action would not directly impact any publicly owned parks or recreation areas along the corridor. Additional information is included in Section 6.11, *Parks and Recreation Areas.*

- **Visual –** The Proposed Action would have a minor effect on the local visual environment within the majority of the corridor. The proposed trackwork would be largely within the depressed rights-of-way, below the normal visible landscape. The stations would be along and within the right-of-way to the greatest extent possible, minimizing the overall visual impact. The new stations would be visible from their street access points and from nearby bridges.

  The local community would experience temporary visual impacts during construction. The Proposed Action would require acquiring property, demolishing buildings, constructing new Green Line track and stations, and relocating the commuter rail track within the existing right-of-way.

  Consultation with the MHC and the Somerville Historic Preservation Commission will ensure the design of a noise barrier behind the National Register-listed Susan Russell House and the design of the Gilman Square Station and Lowell Street Station are context sensitive. The loss of wooded areas along the rights-of-way would be a visual change, but landscaping and noise barriers would reduce the overall visual effect of vegetation losses. Additional information is included in Section 6.12, *Visual Environment*, of this EA.

- **Cultural Resources/Section 106 of the National Historic Preservation Act –** The Proposed Action would have an adverse effect on seven historic resources listed or eligible for listing on the National Register of Historic Places:

  - National Register-eligible Lechmere Viaduct in Boston and Cambridge (for acquisition and demolition of the steel elevated portion);
  - National Register-listed Charles River Basin Historic District (for acquisition and demolition of a portion of the Lechmere Viaduct, a contributing structure to the District);
  - National Register-eligible Lechmere Station in Cambridge (for abandonment and demolition);
  - National Register-eligible Somerville Automobile Company in Medford and Somerville (for acquisition and demolition);
  - National Register-listed Susan Russell House in Somerville (for potential visual impacts resulting from noise barriers);

- National Register-eligible Gilman Square Historic District in Somerville (for potential visual impacts due to the proposed Gilman Square Station); and
- National Register-eligible Powder House/Winter Hill Historic District in Somerville (for potential visual impacts due to the proposed Lowell Street Station).

A Memorandum of Agreement (MOA) (provided in Appendix G, *Memorandum of Agreement*) has been developed that specifies the measures that would be implemented to mitigate the adverse effects. Mitigation measures, including archival photographic documentation and historical interpretation, are discussed in the MOA and also in Chapter 7, *Project and Mitigation Commitments,* of this EA.

Noise barriers would indirectly impact the visual environment of the National Register-eligible Tufts University Curtis Hall, but would not change its historic architectural character. Track vibration isolation (such as ballast mats, floating slabs, and special trackwork and fasteners) would effectively mitigate potential vibration impact at the National Register-eligible Tufts University Bray Laboratory property, leaving no residual effect from vibration.

Two areas of archeological sensitivity were previously identified within the project Area of Potential Effect (APE). The project construction would not affect one area, and subsequent investigations found that there is extensive fill and/or previously disturbed belowground soil contexts at the second location. Therefore, it is unlikely that intact archeological resources would be discovered during construction. However, should any unidentified archaeological resources be discovered during construction, MassDOT would ensure that appropriate notification and preservation procedures are followed, as stipulated in the MOA (Appendix G, *Memorandum of Agreement*). Additional information is included in Section 6.13, *Cultural Resources,* of this EA.

- **Hazardous Materials –** Phase I Environmental Site Assessments conducted for the properties required for acquisition identified 28 Recognized Environmental Concerns (RECs) that would be addressed during construction. The Proposed Action would remediate these sites within the project boundaries that contain contaminated soils. Each REC and associated impact to the project will be assessed at the completion of Phase II subsurface investigations currently being conducted in order to better estimate disposal costs and potential regulatory obligations. Hazardous materials management protocols during construction would include special handling, dust control, and management and disposal of contaminated soil and groundwater in order to prevent construction delays and to provide adequate protection to workers and any nearby sensitive receptors. Additional information is included in Section 6.14, *Hazardous Materials and Solid Waste,* of this EA.
- **Indirect and Cumulative Impacts –** The Proposed Action would not have adverse indirect and cumulative impacts. The extension of rail service through the project study area provides opportunities for the cities to modify their zoning and create infill development. The Proposed Action would support a number of major redevelopment projects that are currently planned and underway near the proposed

station sites. The Green Line Extension project would focus growth into patterns and places that would increase the number of viable travel options available to corridor residents and employees, including transit, walking, and bicycling. While these development projects could help boost the regional economy and the study area neighborhoods, local public policy to preserve affordability for moderate-income residents and small businesses should be implemented to mitigate transit-related increases in land values, which could result in neighborhood gentrification. Additional information is included in Section 6.15, *Indirect and Cumulative Effects*, of this EA.

- **Section 4(f) Resources –** The Proposed Action would not directly impact or result in a constructive use of publicly owned park, recreation area or wildlife and waterfowl refuge, protected by Section 4(f) of the U.S. Department of Transportation Act of 1966.[9] Additional information is included in Chapter 8, *Section 4(f) Evaluation,* of this EA. The Proposed Action would require the use of four National Register-eligible historic properties through the alteration of land currently used for transportation purposes or permanent acquisition of additional land for transportation purposes. Avoidance alternatives were evaluated and there are no feasible and prudent alternatives to avoid the use of property from the following historic resources:
  - The Lechmere Viaduct in Boston and Cambridge (due to partial demolition of property);
  - The Lechmere Station in Cambridge (due to abandonment and demolition of property);
  - The Somerville Automobile Company in Medford and Somerville near the proposed Ball Square Station (due to acquisition and demolition of property); and
  - The Reid and Murdock Company Warehouse, located within the National Register-eligible Gilman Square Historic District, in Somerville (partial acquisition and demolition of adjacent parking area and a railroad loading dock in the rear [south] elevation).[10]

9 Section 4(f) of the United States Department of Transportation Act of 1966 (Amended March 12, 2008 in 73 FR 13395; implemented at 23 U.S.C. 138 and recodified at 49 United States Code, Subtitle I, Section 303(c). Available at: http://www.gpo.gov/fdsys/pkg/FR-2008-03-12/pdf/E8-4596.pdf

10 The Proposed Action requires partial acquisition of non-contributing elements of the National Register-eligible Reid and Murdock Company Warehouse property and blockage of access to a 3-bay garage, which was determined as a no adverse effect under Section 106 of the NHPA; however, a portion of the property would be acquired resulting in a Section 4(f) use.

## MassDOT's Project and Mitigation Commitments

Potential permanent impacts resulting from constructing the Proposed Action would be mitigated to the extent practicable, as described in Chapter 7, *Project and Mitigation Commitments*, of this EA and summarized in Table ES-2.

Temporary, short-term impacts from construction activities would be mitigated to the extent practicable. Appropriate construction mitigation measures would be incorporated into the contract documents and specifications governing the activities of contractors and subcontractors constructing elements of the Proposed Action. On-site resident engineers and inspectors would monitor all construction activities to ensure that mitigation measures are properly implemented. This monitoring will include maintaining a "Tracking Sheet" that will be included with project status reports. The construction mitigation measures are summarized in Table ES-3.

MassDOT and the MBTA are committed to continuing a robust public involvement process during the construction of the Green Line Extension project. The process would a) inform the public of construction plans, b) provide regular updates on construction, traffic detours, impacts, and mitigation measures, and c) solve problems that arise during construction. MassDOT and the MBTA would achieve these goals in part by requiring the Green Line Extension project construction contractor to commit to a spectrum of outreach activities and efforts to mitigate the impacts of construction. MassDOT and the MBTA would hold the construction contractor to these obligations. Working together, agency and contractor staff members would be dedicated to implementing these communication and problem-solving strategies. Key elements of the construction outreach plan are provided in Table ES-3.

Table ES-2 Project and Mitigation Commitments

| Human and Environmental Resources | Mitigation Measure | Implementation Schedule | Implementation Responsibility |
|---|---|---|---|
| Traffic and Transportation Systems | Provide roadway and signal modifications at 12 specific intersections in order to prevent adverse traffic impacts from the project (See Section 7.3.3 and Figure 5.6-1, of this EA):<br>➤ Boston Avenue at Winthrop Street<br>➤ Boston Avenue at College Avenue<br>➤ Washington Street at McGrath Highway<br>➤ Prospect Street at Somerville Avenue<br>➤ Washington Street at Somerville Avenue/Webster Street<br>➤ Washington Street at Tufts Street<br>➤ Medford Street at Pearl Street<br>➤ Broadway at Boston Avenue/Rogers Avenue<br>➤ Monsignor O'Brien Highway at Third Street<br>➤ Monsignor O'Brien Highway at Water Street<br>➤ Monsignor O'Brien Highway at North First Street/East Street/Cambridge<br>➤ Cambridge Street at First Street | Within 12 months after revenue service | MBTA D/B Contractor[1] |
| | Provide pedestrian improvements at 29 specific locations to improve pedestrian flow and safety (See Section 7.3.3, Table 7.3-1, and Figure 5.6-1, of this EA.):<br>➤ Boston Avenue at North Street<br>➤ Boston Avenue at Winthrop Street<br>➤ Boston Avenue between Winthrop Street and College Avenue (mid-block)<br>➤ Boston Avenue at Harvard Street<br>➤ Powder House Rotary<br>➤ Boston Avenue at Broadway<br>➤ College Avenue between Boston Street and Frederick Avenue (mid-block)<br>➤ College Avenue at George Street<br>➤ Main Street at George Street<br>➤ Main Street at Mystic Valley Parkway Ramps<br>➤ Main Street at Harvard Street<br>➤ Main Street at Mystic Avenue<br>➤ Medford Street at Broadway<br>➤ Medford Street at Lowell Street<br>➤ Medford Street at Central Street<br>➤ Medford Street at School Street<br>➤ Medford Street at Pearl Street<br>➤ Medford Street at Walnut Street<br>➤ Medford Street at Highland Avenue<br>➤ Highland Avenue at Lowell Street<br>➤ Highland Avenue at Central Street<br>➤ Washington Street at McGrath Highway<br>➤ Washington Street at Tufts Street<br>➤ Washington Street at Inner Belt Road | Within 12 months before revenue service | MBTA D/B Contractor[1] |

Table ES-2 Project and Mitigation Commitments (Continued)

| Human and Environmental Resources | Mitigation Measure | Implementation Schedule | Implementation Responsibility |
|---|---|---|---|
| Traffic and Transportation Systems (continued) | ➤ Medford Street at Somerville Avenue /McGrath Highway<br>➤ Washington Street at Somerville Avenue/Prospect Street<br>➤ Washington Street at Somerville Avenue/Webster Street<br>➤ Washington Street at Kirkland Street<br>➤ Prospect Street at Webster Street | Within 12 months after revenue service | MBTA D/B Contractor[1] |
| | Optimize traffic signal timing and phasing to maximize the efficiency of signalized intersections in the Proposed Action. | Within 12 months before revenue service | MBTA D/B Contractor[1] |
| | Work with cities to develop station-area parking enforcement plans. | Within 12 months before revenue service | MBTA |
| | Work with the MBTA to evaluate opportunities to improve connections between the new stations and existing bus connections. | During design and construction | MBTA D/B Contractor[1] |
| | Work with cities and applicable emergency personnel during design of intersection mitigation measures, including the development of construction management and detour plans. | During design and construction | MBTA PM/CM Team[2] |
| Noise | Mitigate noise impacts by providing noise barriers or sound insulation. Provide mitigation for moderate noise impact where existing day-night sound levels (Ldn) are above 65 dBA. Provide mitigation for impacts with no significant outdoor land use if interior noise levels are above 45 dBA from project sources or single-event maximum noise levels (Lmax) above 65 dBA. Provide 17 noise barriers totaling approximately 12,700 feet in length at the following locations (See Section 7.3.4, Tables 7.3-6 and 7.3-7, and Figures 6.7-1 to 6.7-6, of this EA.):<br>➤ N1 - Glass Factory Condominiums and Hampton Inn (1,400 feet)<br>➤ N2 - Brickbottom (northeast façade) (1,350 feet)<br>➤ N3 - Brickbottom (south façade) (1,400 feet)<br>➤ N4 - Alston Street (300 feet)<br>➤ N5 - Between Cross Street and McGrath Highway (Avon Place) (500 feet)<br>➤ N6 - Between McGrath Highway and Walnut Street (Gilman Street) (750 feet)<br>➤ N7 - Between School Street and Sycamore Street (Richdale Avenue) (850 feet)<br>➤ N8 - Sycamore Street near Richdale Avenue (200 feet)<br>➤ N9 - Vernon Street (750 feet)<br>➤ N10 - Nashua Street/Henderson Street/Hinckley Street (1,000 feet)<br>➤ N11 - Trum Playground (100 feet)<br>➤ N12 - Cedar Street and Wilson Avenue (400 feet)<br>➤ N13 - Between Cedar Street and Broadway (Broadway) (800 feet) | Early phases of construction, where appropriate | MBTA D/B Contractor[1] |

Table ES-2 Project and Mitigation Commitments (Continued)

| Human and Environmental Resources | Mitigation Measure | Implementation Schedule | Implementation Responsibility |
|---|---|---|---|
| Noise (continued) | ➤ N14 - Newbern Avenue/Morton Avenue/Granville Avenue (1,200 feet)<br>➤ N15 - Burget Avenue (850 feet)<br>➤ N16 - Horace Street (250 feet)<br>➤ N17 - Walnut Street Center (600 feet) | Early phases of construction, where appropriate | MBTA D/B Contractor[1] |
| | Provide sound insulation improvements at the following locations (See Section 7.3.4 and Figures 6.7-1 to 6.7-6, of this EA.):<br>➤ Pearl Street Apartment building<br>➤ Powderhouse Condominiums<br>➤ Outside the Lines Studio building<br>➤ Tufts University Science and Technology Center | Early phases of construction, where appropriate | MBTA D/B Contractor[1] |
| | Monitor noise after service starts (with the proposed mitigation in place) to evaluate whether the actual noise levels correspond with the modeled values and take appropriate corrective actions if the actual values are found to be higher that the projections. | Within 12 months after revenue service | MBTA PM/CM Team[2] |
| Vibration | Mitigate vibration impacts by providing a total of 21,500 track-feet of track vibration isolation in the form of ballast mats, resiliently supported ties or resilient rail fasteners at the following 19 locations (See Section 7.3.5, Table 7.3-9 and Figures 6.7-1 and 6.8-1 to 6.8-5, of this EA.):<br>➤ V1 - Glass Factory Condominiums<br>➤ V2 - Brickbottom Artists Building (northeast façade)<br>➤ V3 - Brickbottom Artists Building (south façade)<br>➤ V4 - Alston Street (south of Cross Street)<br>➤ V5 - Tufts Street/Avon Place/Auburn Avenue (south of Cross Street to McGrath Highway)<br>➤ V6 - Gilman Street (McGrath Highway to Walnut Street)<br>➤ V7 - Medford Street (north of Walnut Street)<br>➤ V8 - Pearl Street Apartments<br>➤ V9 - Richdale Avenue (School Street to Sycamore Street)<br>➤ V10 - Lowell Street/Nashua Street/Hinckley Street/Berwick Street (Lowell Street to Charles E Ryan Road)<br>➤ V11 - Murdock Street (south of Cedar Street)<br>➤ V12 - Cedar Street (north of Cedar Street)<br>➤ V13 - Newbern Avenue/Morton Avenue/Granville Avenue/Winchester Place/Wareham Street (Broadway to Warren Street)<br>➤ V14 - Tufts Science and Technology Center<br>➤ V15 - Tufts Bacon Hall<br>➤ V16 - Outside the Lines Artist Studio<br>➤ V17 - Tufts Bray Laboratory<br>➤ V18 - Tufts Curtis Hall<br>➤ V19 - Horace Street | Within 12 months before revenue service | MBTA D/B Contractor[1] |

Table ES-2 Project and Mitigation Commitments (Continued)

| Human and Environmental Resources | Mitigation Measure | Implementation Schedule | Implementation Responsibility |
|---|---|---|---|
| Vibration (continued) | Relocate specially engineered trackwork to further minimize or mitigate potential vibration impacts at the following crossover and turnout locations (See Section 7.3.5, Table 7.3-10 and Figures 6.7-1 and 6.8-1 to 6.8-5, of this EA.):<br>➤ A - Brickbottom Artists Building South Façade Green Line Turnout (Union Square Outbound Mainline to Union Square Outbound Yard Lead)<br>➤ B - Brickbottom Artists Building South Façade Green Line Turnout (Union Square Inbound Mainline to Union Square Inbound Yard Lead)<br>➤ C - Brickbottom Artists Building South Façade Two Commuter Turnouts (Fitchburg Mainline to BET Drill Track and to Spur Line)<br>➤ D - Granville Avenue / Winchester Place Commuter Interlocking (two double crossovers)<br>➤ E - College Avenue Green Line Number 8 Double Diamond Crossover | PE Design Phase | MBTA PM/CM Team[2] |
| | Monitor vibration after service starts (with proposed mitigation in place) to evaluate whether the actual vibration levels correspond with the modeled values and take appropriate corrective actions if the actual values are found to be higher than the projections | Within 12 months after revenue service | MBTA PM/CM Team[2] |
| Hazardous Materials | Consult with MassDEP during design and construction to ensure planning and implementation of demolition and management of contaminated soils is consistent with applicable MassDEP regulations and recommendations. | During design and construction | MBTA Environmental Team[3] |
| Socioeconomics | In accordance with Uniform Act procedures, work with property owners to provide fair market value of acquisition and job relocations. | Prior to beginning of construction | MassDOT/ MBTA Real Estate Team[4] |
| Land Use | Work with the community in the area of the future Mystic Valley/Route 16 to consider land use and station design elements. | Prior to beginning of construction | MassDOT/ MAPC |
| | Complete the final design for the proposed Somerville Community Path between Lowell Street and the Inner Belt area. Work with City of Somerville to identify opportunities for state and Federal funding for construction of Community Path. | Within 12 months before revenue service | MBTA PM/CM Team[2] |
| Water Quality/ Stormwater | Update the Operation and Maintenance plan in the Stormwater Pollution Prevention Plan (SWPPP) to include a detailed outline of inspection and cleaning schedules for stormwater management practices, including detention areas and deep sump catch basins. | Within 12 months before revenue service | MBTA D/B Contractor[1] |
| | Implement all aspects of the SWPPP including recommendations in annual updates based on new or improved procedures or changes to operations. | Within 12 months after revenue service | MBTA D/B Contractor[1] |
| Visual Environment | Provide vegetation on and/or above retaining walls to minimize visual changes. | During design and construction | MBTA D/B Contractor[1] |
| | Work with affected communities on design of noise barriers and vegetated walls. | PE Design Phase | MBTA PM/CM Team[2] |

Table ES-2 Project and Mitigation Commitments (Continued)

| Human and Environmental Resources | Mitigation Measure | Implementation Schedule | Implementation Responsibility |
|---|---|---|---|
| Cultural Resources and Section 4(f) Resources | Perform archival photographic and written documentation of historic structures to be removed or altered (Lechmere Station/Lechmere Viaduct, Somerville Automobile Company Building) | Prior to beginning of construction | MBTA D/B Contractor[1] |
| | Following MBTA design protocol review, develop interpretative displays of Lechmere Station/Lechmere Viaduct and the Somerville Automobile Company Building, in consultation with the FTA, the MHC and relevant historical commissions. | During design and construction | MBTA D/B Contractor[1] |
| | Submit design plans and construction specifications for project elements that affect above-ground historic properties for review by MHC, local historical commissions, and the Design Working Group. | Prior to beginning of construction | MBTA PM/CM Team[2] |
| | Construct noise barrier adjacent to historic Susan Russell House with context-sensitive materials and colors. | During design and construction | MBTA D/B Contractor[1] |
| Public Involvement | Continue civic engagement opportunities during the design process. Provide transparent public information and outreach process through construction. | Duration of project | MassDOT/ MBTA |
| | Engage interested parties through the Design Working Group. | Duration of project | MassDOT/ MBTA |
| | Conduct land use workshops with affected communities to further identify community needs and issues near the proposed station areas. | Completed in May/June 2010 | MassDOT |
| Design | As design advances, facilitate future transit/transportation projects such as light rail expansion or connections to existing infrastructure to the extent possible. | Prior to beginning of construction | MBTA D/B Contractor[1] |
| | Implement “green” design elements (recycled or recyclable materials or incorporate vegetation) in design of proposed retaining walls, stations and maintenance and storage facility. | During design and construction | MBTA D/B Contractor[1] |
| | During design, refine project designs to further minimize temporary and permanent impacts on local neighborhoods and property owners. | Prior to beginning of construction | MBTA D/B Contractor[1] |
| | Design all stations in compliance with ADA standards, Massachusetts AAB standards; MBTA’s settlement agreement with the Boston Center for Independent Living (BCIL) and applicable National Fire Protection Association standards. | Prior to beginning of construction | MBTA D/B Contractor[1] |

1 MBTA D/B Contractor = Contractor selected and coordinated by the MBTA to handle Design and Build phase of the project
2 MBTA PM/CM Team = Team selected by the MBTA to handle Program Management, Contract Management and oversight of Preliminary Engineering.
3 MBTA Environmental Team = MBTA Environmental Department Staff
4 MBTA Real Estate Team = MBTA Real Estate Department Staff and asset manager Transit Realty Associates (TRA)
TBD = To be determined during final design
N/A = Cost not applicable for this item

Table ES-3 Summary of Construction Period Mitigation Commitments to be Implemented by MBTA D/B Contractor during Construction

| Environmental Categories | Mitigation | Implementation Schedule | Implementation Responsibility |
|---|---|---|---|
| General | ➤ Prior to construction, prepare a detailed plan to address various construction period impacts to various environmental resources (vehicular traffic, pedestrian and bicycle, on-street parking, public access, emergency access to local businesses and residences, dust, noise, odor, rodents, construction-related nuisance conditions) through coordination with cities and appropriate emergency personnel. | Prior to construction | MBTA PM/CM Team[1] |
| Traffic and Transportation Systems | ➤ Establish temporary detours to minimize traffic disruptions due to construction. | During construction | MBTA D/B Contractor[2] |
| | ➤ Stage bridge construction to ensure that adjacent bridges are not closed simultaneously. | During construction | MBTA D/B Contractor[2] |
| | ➤ Work with cities and applicable emergency personnel to ensure that appropriate safety measures are incorporated throughout construction. | During construction | MassDOT |
| Air Quality | ➤ Apply water to dry soil to prevent dust production. | During construction | MBTA D/B Contractor[2] |
| | ➤ Use water for compaction in the fill areas and as a dust retardant in both the soil cut areas and haul roads. | During construction | MBTA D/B Contractor[2] |
| | ➤ Follow existing MassDEP's Solid Waste and Air Quality Control regulations and MBTA retrofit procedures for construction equipment to reduce emissions. | During construction | MBTA D/B Contractor[2] |
| | ➤ Comply with MassDEP's idling regulations. Post idling restriction signage on project construction sites. | During construction | MBTA D/B Contractor[2] |
| Noise | ➤ Prepare a Noise Control Plan in conjunction with the contractor's specific equipment and methods of construction. | During construction | MBTA D/B Contractor[2] |
| | ➤ Use specially quieted equipment with enclosed engines and/or high-performance mufflers. | During construction | MBTA D/B Contractor[2] |
| | ➤ Perform construction equipment noise certification testing. | During construction | MBTA D/B Contractor[2] |
| | ➤ Avoid nighttime construction in residential neighborhoods. | During construction | MBTA D/B Contractor[2] |
| | ➤ Require ambient-adjusting or manually adjusted backup alarms set to 5 dBA over background levels. | During construction | MBTA D/B Contractor[2] |
| | ➤ Keep truck idling to a minimum. | During construction | MBTA D/B Contractor[2] |
| | ➤ Set acoustic shield requirement for jackhammers, chainsaws, and pavement breakers. | During construction | MBTA D/B Contractor[2] |
| | ➤ Develop methods for projecting construction noise levels. | During construction | MBTA D/B Contractor[2] |
| | ➤ Develop methods for responding to community complaints. | During construction | MBTA D/B Contractor[2] |
| | ➤ Establish a protocol for reporting noise monitoring results, noise reduction measures used, and responses to the community. | During construction | MBTA D/B Contractor[2] |

Table ES-3 Summary of Construction Period Mitigation Commitments to be Implemented by MBTA D/B Contractor during Construction (Continued)

| Environmental Categories | Mitigation | Implementation Schedule | Implementation Responsibility |
|---|---|---|---|
| Noise (continued) | ➤ Use shields, shrouds, or intake and exhaust mufflers to control construction noise level | During construction | MBTA D/B Contractor[2] |
| | ➤ Apply noise deadening materials to chutes or storage bins. | During construction | MBTA D/B Contractor[2] |
| | ➤ Install temporary noise barriers. | During construction | MBTA D/B Contractor[2] |
| | ➤ Apply acoustic enclosures. | During construction | MBTA D/B Contractor[2] |
| | ➤ Implement specialized back-up alarms. | During construction | MBTA D/B Contractor[2] |
| | ➤ Limit the size of generators and the duration of their use. | During construction | MBTA D/B Contractor[2] |
| | ➤ Develop truck routes that minimize exposure to noise-sensitive sites. | During construction | MBTA D/B Contractor[2] |
| | ➤ Develop other detailed engineering noise control measures, as appropriate. | During construction | MBTA D/B Contractor[2] |
| | ➤ Route construction equipment and vehicles through areas that would cause the least disturbance to nearby receptors where possible. | During construction | MBTA D/B Contractor[2] |
| | ➤ Fit any air-powered equipment with pneumatic exhaust silencers. | Prior to construction | MBTA D/B Contractor[2] |
| | ➤ Locate stationary construction equipment as far as possible from noise-sensitive sites. | During construction | MBTA D/B Contractor[2] |
| | ➤ Construct noise barriers, such as temporary walls or piles of excavated material, between noisy activities and noise-sensitive receivers. | Prior to construction | MBTA D/B Contractor[2] |
| | ➤ Monitor noise after service starts (with the proposed mitigation in place) to evaluate whether the actual noise levels correspond with the modeled values and take appropriate corrective actions if the actual values are found to be higher than the projections. | Within 12 months after revenue service | MBTA PM/CM Team[1] |
| Vibration | ➤ Configure truck routes that minimize exposure to vibration sensitive receptors and maintain smooth roadway surfaces. | During construction | MBTA D/B Contractor[2] |
| | ➤ Avoid nighttime construction in residential neighborhoods. | During construction | MBTA D/B Contractor[2] |
| | ➤ Use alternative construction methods to minimize the use of impact and vibratory equipment (e.g., pile drivers and compactors). | During construction | MBTA D/B Contractor[2] |
| | ➤ Monitor vibration after service starts (with the proposed mitigation in place) to evaluate whether the actual vibration levels correspond with the modeled values and take appropriate corrective actions if the actual values are found to be higher than the projections. | Within 12 months after revenue service | MBTA PM/CM Team[1] |
| Water Quality/ Stormwater | ➤ Install detention and infiltration systems to infiltrate peak runoff and to prevent any increase in peak flows to municipal stormwater drainage systems and to remove total suspended solids (TSS) from stormwater runoff prior to discharge. | During construction | MBTA D/B Contractor[2] |
| | ➤ Install hydrodynamic particle separators to treat pavement runoff. | During construction | MBTA D/B Contractor[2] |

Table ES-3 Summary of Construction Period Mitigation Commitments to be Implemented by MBTA D/B Contractor during Construction (Continued)

| Environmental Categories | Mitigation | Implementation Schedule | Implementation Responsibility |
|---|---|---|---|
| Water Quality/ Stormwater (continued) | ➤ Reinforce slopes using a hydroseed mix with a resin base, native vegetation, or other approved methods. | During construction | MBTA D/B Contractor[2] |
| | ➤ Use Low Impact Development practices, where feasible, to maintain natural hydrology (e.g., raingardens to treat disconnected roof drainage and/or parking runoff). | During construction | MBTA D/B Contractor[2] |
| | ➤ Develop and implement a SWPPP in accordance with NPDES and MassDEP standards. | Prior to construction | MBTA Design Team[3] |
| | ➤ Stabilize any highly erosive soils with erosion control blankets and other stabilization methods, as necessary. | During construction | MBTA D/B Contractor[2] |
| | ➤ Use dewatering controls, if necessary. | During construction | MBTA D/B Contractor[2] |
| | ➤ Install a gravel entrance at construction sites to prevent sediment from being tracked onto roadways and potentially discharged to surface waters. | During construction | MBTA D/B Contractor[2] |
| | ➤ Maintain construction equipment to prevent oil and fuel leaks and install catch basin protection as needed. | During construction | MBTA D/B Contractor[2] |
| Hazardous Materials | ➤ Consult with MassDEP to ensure planning and implementation of demolition and management of contaminated soils is consistent with applicable MassDEP regulations and recommendations. | During design and construction | MBTA Environmental Team with D/B Contracto[2, 4] |
| | ➤ Follow all protocols to adequately characterize, stockpile and dispose of materials encountered during construction. | During design and construction | MBTA D/B Contractor[2] |
| Outreach | ➤ Establishing a project construction office. | During construction | MBTA D/B Contractor[2] |
| | ➤ Establishing a Green Line Extension project Ombudsman position who would field all construction-period comments and complaints, coordinate with the cities, and respond to public concerns. | During construction | MBTA D/B Contractor[2] |
| | ➤ Establish a Construction Working Group to advise MassDOT and the MBTA. | During construction | MBTA D/B Contractor[2] |
| | ➤ Establish a project email address and 24-hour phone hotline for public concerns. | During construction | MBTA |
| | ➤ Provide frequent website updates of construction activities at www.mass.gov/greenlineextension | During construction | MassDOT/MBTA |
| | ➤ Host neighborhood construction kick-off meetings. | During construction | MBTA D/B Contractor[2] |
| | ➤ Produce quarterly construction updates. | During construction | MBTA D/B Contractor[2] |
| | ➤ Develop a business outreach plan to assist local businesses during construction. | During construction | MBTA D/B Contractor[2] |

1 MBTA PM/CM Team = Team selected by the MBTA to handle Program Management, Construction Management and oversight of Preliminary Engineering.
2 MBTA D/B Contractor = Contractor selected and coordinated by the MBTA to handle Design and Build phase of the project
3 MBTA Design Team = MBTA management team that oversees design and construction projects.
4 MBTA Environmental Team = MBTA Environmental Department Staff

## What Permits and Approvals are Required?

The Proposed Action would require permits and approvals from several local, state, and Federal agencies, as listed in Table ES-4.

### Table ES-4 Possible Permits or Approvals

| Agency | Approval or Permit |
|---|---|
| U.S. Environmental Protection Agency Region I | ➤ Compliance with NPDES National Construction General Permit for stormwater discharges during construction<br>➤ Compliance with NPDES Small Municipal Separate Storm Sewer System (MS4) Genera Permit |
| Massachusetts Department of Conservation and Recreation (DCR) | ➤ Coordination/approval for crosswalk marking improvements and signal coordination in proximity to DCR property |
| Massachusetts Water Resources Authority (MWRA) | ➤ Direct Connect Permit for sewer connections<br>➤ Compliance with MWRA NPDES permit for stormwater discharges through the Combined Sewer Overflow (CSO) system (Somerville CSO areas only)<br>➤ Section 61 Finding<br>➤ 8(m) Permit |
| Massachusetts Historical Commission (MHC) | ➤ Review project for impacts to historic and archeological properties and approval for compliance with Massachusetts General Law (M.G.L.) Chapter 9, Sections 26-27C<br>➤ Memorandum of Agreement (with the FTA, MassDOT, and MBTA)<br>➤ Section 61 Finding |
| City of Medford | ➤ Approval of temporary closings/detours associated with bridge reconstruction<br>➤ Building/sewer permits as needed for station construction<br>➤ Approval for intersection and signal modifications, as appropriate<br>➤ Stormwater permit, as needed<br>➤ Street opening permits, as needed |
| City of Somerville | ➤ Approval of temporary closings/detours associated with bridge reconstruction<br>➤ Building/sewer permits as needed for station construction and maintenance facility<br>➤ Approval for intersection and signal modifications, as appropriate<br>➤ Stormwater permit, as needed<br>➤ Street opening permits, as needed |
| City of Cambridge | ➤ Building/sewer permits as needed for station construction<br>➤ Approval for intersection and signal modifications, as appropriate<br>➤ Stormwater permit, as needed<br>➤ Street opening permits, as needed |

# 1

# Introduction and Background

## 1.1 Introduction

The Green Line Extension project (the "project") is an initiative of the Massachusetts Department of Transportation (MassDOT)[1] and the Massachusetts Bay Transportation Authority (MBTA) to enhance transit services in order to improve mobility and regional access for residents in the communities of Cambridge, Somerville, and Medford. The project is required by the State Implementation Plan (SIP) and fulfills a longstanding commitment of the Central Artery/Tunnel project to increase public transit. The project study area is shown on Figure 1.1-1.

Project funding would come both from the Federal Transit Administration (FTA) and from Commonwealth bonding. This project has concluded the Massachusetts Environmental Policy Act (MEPA) environmental review process with the issuance of a final Certificate on July 30, 2010, on the Final Environmental Impact Report (FEIR). In order to use federal funding, the project also requires review under the National Environmental Policy Act (NEPA). This Environmental Assessment (EA) has been prepared in compliance with Council on Environmental Quality (CEQ) regulations for implementing NEPA, as amended (40 Code of Federal Regulations [CFR] Parts 1500-1508); FTA and Federal Highway Administration (FHWA) regulations (23 CFR Part 771); 49 United States Code (USC) Section 303[2], and Section 309 of the Clean Air Act, as amended.

The Green Line Extension project is proposed to be built in two phases with an initial segment, the "Proposed Action," being constructed to College Avenue in Medford with a spur to Union Square in Somerville (Figure 1.1-2). The second phase of the project, the "Future Full-Build Alternative," would extend the project from College Avenue Station to Mystic Valley Parkway/Route 16 Station, as described and evaluated in the Draft Environmental Impact Report/Environmental Assessment

1 In the Fall of 2009, the Massachusetts Department of Transportation (MassDOT) replaced the Executive Office of Transportation and Public Works as the umbrella transportation agency for the Commonwealth.
2 Formerly known as Section 4(f) of the United States (U.S.) Department of Transportation (DOT) Act of 1966, and commonly referred to as Section 4(f).

(DEIR/EA) as Alternative 2. Although the extension to Mystic Valley Parkway/ Route 16 in a single phase was considered for the Green Line Extension project, limitations on available funding prohibit the Commonwealth from extending the Green Line beyond College Avenue at this time. The second phase is not part of the Proposed Action and is not the subject of this EA.

This EA describes the Proposed Action and its environmental impacts, and provides additional analyses of the Proposed Action that have been conducted since the release of the October 2009 DEIR/EA and June 2010 FEIR. The DEIR/EA and FEIR are available on the project website: www.mass.gov/greenlineextension.

## 1.2 Project History

Numerous studies over the last 40 years have explored extending transit from Lechmere Station (the current terminus of the Green Line) along the existing MBTA Lowell or MBTA Fitchburg Line commuter rail rights-of-way. The 2005 *Beyond Lechmere Northwest Corridor Study*[3] was a Major Investment Study/Alternatives Analysis (MIS/AA) that evaluated a wide range of technologies and operating plans for a future extension. The *Beyond Lechmere Northwest Corridor Study* investigated a range of cost-effective transit solutions that would increase transit accessibility, improve corridor mobility, increase transit services, and support opportunities for smart growth initiatives and sustainable development, but did not identify a preferred alternative.

An Expanded Environmental Notification Form (EENF) was submitted to the Commonwealth of Massachusetts Secretary of the Executive Office of Energy and Environmental Affairs (EEA) on October 10, 2006. The Secretary issued a Certificate on the EENF on December 1, 2006, requiring a DEIR for the Green Line Extension project.

After the submission of the EENF, the project study area was expanded to include relocating Lechmere Station. Relocating Lechmere Station was previously reviewed under MEPA as part of the NorthPoint development project (EEA # 12651), but was not previously reviewed under NEPA.

On October 15, 2009, MassDOT filed the Green Line Extension project DEIR/EA with the MEPA Office and distributed the document as required by FTA and NEPA regulations. Six "Build" Alternatives and a Baseline Alternative were evaluated in the DEIR/EA. The Baseline Alternative was evaluated to identify the best option for meeting the transportation needs of the project study area with smaller capital

3 Massachusetts Bay Transportation Authority. *Beyond Lechmere Northwest Corridor Study Major Investment Study/Alternatives Analysis*. Prepared by Vanasse Hangen Brustlin, Inc. August 2005. Available at http://www.greenlineextension.org/docs_beyondLechmere.html.

investment than were estimated for the Build Alternatives (Figure 1.2-1). The Baseline Alternative includes enhanced MBTA bus service within the project study area, including expanding the existing Route 80 between Lechmere Station and the proposed College Avenue Station site parallel to the MBTA Lowell Line commuter rail right-of-way, and a new shuttle bus service between Lechmere Station and Union Square, parallel to the MBTA Fitchburg Line commuter rail right-of-way.

The DEIR/EA included an evaluation of relocating Lechmere Station to the location previously reviewed under MEPA for the NorthPoint development. The need to relocate the station, the alternatives evaluated, and the environmental consequences of moving the station were described.

The vehicle maintenance and storage facility that must be constructed to support the operations of the Green Line Extension project has been extensively studied. The DEIR/EA stated that the "Yard 8 with Adjacent Parcel" site (Yard 8) was selected as the preferred location for the maintenance and storage facility, based on the combination of size, configuration, and adjacency to the Green Line Extension project tracks. The selection of the Yard 8 site prompted local opposition from municipal officials, elected representatives, and abutting residents. To address and resolve these concerns, MassDOT then qualitatively analyzed two additional possible sites for the facility, Option L and Mirror H, selecting the Option L site as the preferred maintenance and storage facility in late 2009.

After public review and comment period, the Secretary of the EEA issued a Certificate on the DEIR on January 15, 2010, requiring the preparation of a limited scope FEIR for the Proposed Action, including:

- Quantitative environmental analysis of both the Option L and Mirror H maintenance facility and storage locations including, for comparative purposes, the prior analysis of Yard 8;
- Narrative discussion clarifying air quality modeling;
- Further evaluation of impacts associated with College Avenue Station as a terminal station;
- Refined conceptual design of Lechmere Station;
- A Public Involvement Plan (PIP) for community participation beyond the environmental process;
- Summary of Proposed Action impacts; and
- Mitigation measures for Proposed Action impacts.

On June 15, 2010, MassDOT filed the Green Line Extension project FEIR with the MEPA Office. The FEIR documented the additional analyses required by the DEIR Certificate. After a 30-day public review and comment period, the Secretary of the

EEA issued a final Certificate on July 30, 2010.[4] The Certificate stated that the Green Line Extension project adequately and properly complies with MEPA and its implementing regulations, and can proceed with state and local permitting.

A number of items have been updated as the conceptual engineering has advanced and additional analysis has been performed. Items that have been revised include:

- **Noise and Vibration** – Additional noise and vibration analyses were conducted and specific mitigation measures identified. The additional noise and vibration analyses were prepared in accordance with FTA guidelines and are summarized in Sections 6.7, *Noise*, and 6.8, *Vibration*, and presented in Appendix F, *Noise and Vibration Technical Report,* of this EA. Additionally, tracks in the vicinity of the Brickbottom Artists Building have been moved farther from the northeast building façade in order to minimize noise impacts in this area.
- **Stations** – Working with the public, local municipalities, and project stakeholders, the proposed station locations and designs were further refined. As described in Section 4.4.4, *Stations*, of this EA, the refinements to station designs include:
  - Modifying the relocated Lechmere Station station layout, busway and roadway, and pedestrian access;
  - Siting the Washington Street Station (formerly Brickbottom Station) closer to Washington Street for better neighborhood access and to minimize property acquisitions; and
  - Refining the conceptual designs at the stations to provide pickup/drop-off as well as emergency egress at all stations.
- **Ridership** – The statewide transportation model, maintained by the Boston Metropolitan Region Planning Organization's Central Transportation Planning Staff (CTPS) was updated with 2009 systemwide passenger survey results and a revised list of programmed future regional projects.
- **Historic/Archeological Resources** – National Historic Preservation Act (NHPA) Section 106 Consultation sessions were held in December 2010 with the Massachusetts Historic Commission (MHC) and the local historical commissions to discuss any historic properties that would be affected by the project. Based on the meetings additional resources were identified and analyzed. A consultation session was offered to interested Tribal Nations to discuss potential archeologically sensitive resources. The Section 106 process is discussed in Section 2.6.3, *Section 106 Consultation Sessions*, Section 5.15, *Cultural Resources*, and Section 6.13, *Cultural Resources*.

4 Commonwealth of Massachusetts, Executive Office of Energy and Environmental Affairs. *Green Line Extension - Certificate of the Secretary of Energy and Environmental Affairs on the Final Environmental Impact Report*, July 30, 2010. Available at: www.mass.gov/greenlineextension

## 1.3 Project Description – Proposed Action

The Proposed Action would provide light rail transit service to College Avenue in Medford and Union Square in Somerville using a two-branch operation, both within existing commuter rail rights-of-way. The 3.4-mile long Medford Branch would operate from a relocated Lechmere Station to College Avenue along the MBTA Lowell Line commuter rail right-of-way. This branch would begin at the relocated Lechmere Station and head northwest, joining the MBTA Lowell Line commuter rail right-of-way just south of Washington Street in Somerville. From Washington Street, the alignment would run parallel to the MBTA Lowell Line to Medford, terminating its route at College Avenue. The 0.9-mile long Union Square Branch would begin at the relocated Lechmere Station as described above, but then turn west to operate along the MBTA Fitchburg Line commuter rail right-of-way to terminate at Union Square in Somerville.

The primary infrastructure improvements include relocating the existing commuter rail lines; constructing approximately four miles of new light rail track and ancillary systems, four multi-span viaducts, seven new stations, and a vehicle maintenance and storage facility; and reconstructing 11 bridge structures to support the extended service.

The MBTA's anticipated daily ridership (boardings and alightings) at the project's seven stations is approximately 49,000 by the year 2030, with approximately 92 percent of these trips beginning in the project's opening year. The Green Line would also see an increase of 25,970 boardings and the entire MBTA system would see an increase of 7,500 new daily linked transit trips as a result of the extension of the Green Line service. The Proposed Action would reduce vehicle miles travelled (VMTs) by 25,728 per day (projected to the year 2030).

Estimated travel time between College Avenue Station and Lechmere Station for the proposed Green Line Medford Branch is 9.5 minutes. Green Line service beyond Lechmere Station for the Medford Branch would operate on headways (time between trains) equal to that of the existing Green Line D branch service: five minutes in the morning and evening peak periods and 10 minutes during off-peak periods.

Estimated travel time between Union Square and Lechmere Station for the proposed Green Line Union Square Branch is 4.5 minutes. Green Line service beyond Lechmere Station for the Union Square Branch would operate on headways equal to that of the existing Green Line E branch service: six minutes in the morning peak period, five minutes in the evening peak period, and between nine and 10 minutes during off-peak periods.

Based on current MBTA subway fares, fares for the Green Line Medford Branch and Union Square Branch would be $1.70 for one-way adult trips using a Charlie Card.

### 1.3.1 Stations

Seven stations would be constructed as part of the Proposed Action:

- Relocated Lechmere Station, Cambridge (relocated to east side of Monsignor O'Brien Highway/Route 28);
- Washington Street Station, Somerville;
- Gilman Square Station, Somerville;
- Lowell Street Station, Somerville;
- Ball Square Station, Somerville/Medford line;
- College Avenue Station, Medford; and
- Union Square Station, Somerville.

The proposed stations are described in detail in Section 4.4.4, *Stations*. Station locations for the Green Line Extension project were identified through an evaluation process and by working with the public and local officials. Important considerations in station siting and configuration included operations and access, as well as impacts to area properties. With the exception of relocated Lechmere Station, the stations are intended to function as neighborhood stations with no provisions for parking.

Stations were designed to meet the project's goals of improved transit access and accessibility, and to minimize impacts to the community associated with land acquisition, traffic, and loss of local parking. The design for each station is envisioned to provide a headhouse with automated fare lines, vending machines, an information booth, and restrooms. Entry to and exit from the platforms would be by elevators, escalators, and stairs. Station access and platform design were based on requirements and guidance provided by the Americans with Disabilities Act (1990) (ADA) and the Commonwealth of Massachusetts Architectural Access Board (AAB), as well as requirements of the MBTA. Station design criteria also considered sustainable features.

### 1.3.2 Vehicle Requirements

The Green Line Extension project vehicle fleet would include a mix of three vehicle types: the two current vehicles (Type 7 high-floor cars and Type 8 low-floor cars) and a new Type 9 low-floor car, which is currently under development. All three vehicle types would be able to operate within the existing system and along the Green Line Extension.

In general, the current Green Line trainsets (or "consists") include two or three cars. For calculating the number of required cars, two-car Green Line trains were conservatively assumed. Based on the 2010 MBTA's Service Delivery Policy,[5] the seating capacity of each Green Line car is 44 to 46 seats, depending on the car type, and the maximum peak load standard is 225 percent of the seated capacity for the peak periods. This translates into a peak period train capacity of 198 to 207 passengers per trainset. In order to accommodate the projected ridership and proposed operating plan for the extension, it was calculated that 24 additional Green Line cars would be needed for the Green Line Extension project. The proposed track and stations have been designed so as not to preclude future platform expansion up to four-car trainsets.

### 1.3.3 Capital Improvements

Capital improvements for the Medford Branch include constructing light rail tracks and overhead contact system (OCS) along the existing railroad right-of-way, to the greatest extent possible, between the relocated Lechmere Station in Cambridge and College Avenue in Medford. The service would extend to College Avenue Station, immediately north of the College Avenue overpass. Since College Avenue would be the terminus for the line under the Proposed Action, additional track lengths would be required north of the station for short-term train storage and operational flexibility.

Some of the existing bridges along the right-of-way would need to be reconstructed to accommodate the additional tracks. The structures that would need to be reconstructed include the Red Bridge (which formerly crossed the MBTA Fitchburg Line but has been removed), Washington Street, Walnut Street, Medford Street, School Street, Lowell Street, Cedar Street, Broadway, Harvard Street, and College Avenue. Existing track and signal equipment would also need to be relocated in order to accommodate the light rail tracks.

The Union Square Branch would require light rail tracks and OCS to be constructed along the MBTA Fitchburg Line between the former Red Bridge and the proposed Union Square Station near Prospect Street. The alignment to Union Square would require reconfiguring the existing signal equipment as well as the commuter rail and freight rail tracks between the MBTA Boston Engine Terminal and Webster Avenue. The existing rail bridge over Medford Street would need to be reconstructed to accommodate the additional tracks.

New signal, communications, and electrical systems would be required for the Green Line Extension project. The Proposed Action would require Automatic Wayside Block Signals to govern Green Line train operations for both the Medford Branch and the Union Square Branch. Multiple communication systems are proposed for MBTA operations, MBTA staff communications, mechanical system monitoring, passenger communications, and emergency reporting.

5 Massachusetts Bay Transportation Authority. *Service Delivery Policy*, June 2, 2010. Available at: http://www.mbta.com/uploadedfiles/About_the_T/T_Projects/T_Projects_List/2010ServiceDeliveryPolicy.pdf

Traction power for the Green Line is provided by 600-volt direct current (DC) through the OCS. The Proposed Action would require traction power substations to power both the Medford Branch and the Union Square Branch. New substations would be required at the maintenance and storage facility site and at Ball Square Station. An existing inactive substation at School Street in Somerville would be reactivated. The traction power feeders and returns would be installed in underground electrical conduits. The OCS would consist of an auto-tension system registered and supported on cantilever-type assemblies, span wire assemblies, and portal bents.[6]

A support facility for storing and servicing the Green Line fleet would be constructed to accommodate the existing north-side Green Line service fleet and the additional 24 vehicles required for the project.

### 1.3.4 Construction

The Proposed Action has been designed to minimize impacts to the corridor municipalities by reducing the footprint of the project and maximizing the use of existing transportation corridors.

Construction staging and sequencing strategies are critical to an efficient project while minimizing the impacts to vehicular traffic, pedestrian traffic, on-street parking, public access, emergency access to local businesses and residences, and general quality of life. Infrastructure and land use adjacent to the railroad corridors present several construction challenges including narrow roadways, urban traffic volumes, and a variety of commercial, industrial, and residential uses that require continuous access, and limited space for construction zones and lay down areas within or near the rail corridor. Existing rail service must be maintained throughout construction.

The current plans for construction staging and sequencing address the constraints of the corridor, impacts to abutters, and other construction issues. More detailed evaluation and staging recommendations would be developed as the design progresses and through coordination with the Cities of Cambridge, Somerville, and Medford, and their respective fire and police departments. This effort would include public input. A comprehensive construction staging and sequencing plan would be developed and included in the final construction contract documents and communicated to the public, through the PIP described in Chapter 2, *Public Involvement and Agency Coordination*.

6 Portal bent – A type of catenary support with a column on both sides of the tracks and a crossbeam on top.

### 1.3.5 Estimated Cost

Ten percent design concept plans for the Proposed Action and detailed capital cost estimates have been completed. The capital improvements include, but are not limited to, construction of track, stations, structures, systems, drainage, utilities, and the maintenance facility. Additional costs include property acquisitions and business relocations as well as vehicle acquisition. The cost of the Proposed Action includes the relocated Lechmere Station. The overall cost of the Proposed Action is currently estimated at approximately $971 million in 2011 dollars, including $82 million for the 24 Green Line vehicles, plus finance charges. Annual operating and maintenance costs would be approximately $24.5 million in 2011 dollars.

The total costs for the Proposed Action were projected to include inflation for the time period in which the project is to be implemented (2019). The "Year-of-Expenditure" (YOE) capital costs for the Proposed Action were calculated to be approximately $1.1 billion in YOE dollars, plus finance charges.

## 1.4 Permits and Approvals

The Green Line Extension project requires review under NEPA in order to use Federal funding. The CEQ regulations for implementing NEPA ensure that information on the social and environmental impacts of any Federally funded action is available to public officials and citizens before decisions are made and before actions are taken.[7]

CEQ regulations direct Federal agencies to integrate into their planning and decision-making impacts to the natural and social sciences, environmental amenities and values, and the design arts along with the necessary engineering and economic considerations.[8] The objective is to balance infrastructure development, economic prosperity, health and environmental protection, community and neighborhood preservation, and quality of life. Based on the current assessment of project impacts, a Finding of No Significant Impact (FONSI) is anticipated for the Green Line Extension project. However, a Public Hearing will be held and comments on this EA will be addressed and considered prior to a final decision.

The Proposed Action would require permits and approvals from several Federal, state, and local agencies. Table 1.1-1 lists the permits and approvals that are anticipated for the Proposed Action.

7 Executive Office of the President, Council on Environmental Quality, *Regulations for Implementing the Procedural Provisions of the National Environmental Policy Act* (40 CFR Parts 1500-1508). Available at: http://ceq.hss.doe.gov/nepa/regs/ceq/toc_ceq.htm

8 United States Department of Transportation, Federal Transit Administration and Federal Highway Administration, *Environmental Impact and Related Procedures* (23 CFR Part 771). Available at: http://www.fta.dot.gov/

Table 1.1-1 Possible Permits or Approvals

| Agency | Approval or Permit |
|---|---|
| U.S. Environmental Protection Agency, Region I | Compliance with National Pollutant Discharge Elimination System (NPDES) Construction General Permit for stormwater discharges during construction |
| | Compliance with NPDES Small Municipal Separate Storm Sewer System (MS4) General Permit |
| Massachusetts Department of Conservation and Recreation (DCR) | Coordination/approval for crosswalk marking improvements and signal coordination in proximity to DCR property |
| Massachusetts Water Resources Authority (MWRA) | Direct Connect Permit for sewer connections |
| | Compliance with MWRA NPDES permit for stormwater discharges through the Combined Sewer Overflow (CSO) system (Somerville CSO areas only) |
| | Section 61 Finding |
| | 8(m) Permit |
| Massachusetts Historical Commission (MHC) | Review project for impacts to historic and archeological properties and approval for compliance with Massachusetts General Laws (M.G.L.) Chapter 9, Sections 26-27C |
| | Memorandum of Agreement (with FTA, MassDOT, and MBTA) |
| | Section 61 Finding |
| City of Medford | Approval of temporary closings/detours associated with bridge reconstruction |
| | Building/sewer permits as needed for station construction |
| | Approval for intersection and signal modifications, as appropriate |
| | Stormwater permit, as needed |
| | Street opening permits, as needed |
| City of Somerville | Approval of temporary closings/detours associated with bridge reconstruction |
| | Building/sewer permits as needed for station construction and maintenance facility |
| | Approval for intersection and signal modifications, as appropriate |
| | Stormwater permit, as needed |
| | Street opening permits, as needed |
| City of Cambridge | Building/sewer permits as needed for station construction |
| | Approval for intersection and signal modifications, as appropriate |
| | Stormwater permit, as needed |
| | Street opening permits, as needed |

## 1.5 Contents of this EA

Chapter 2, *Public Involvement and Agency Coordination*, provides a summary of the public and agency involvement and coordination that has occurred to date, including general responses to comments received on the October 2009 DEIR/EA and the June 2010 FEIR. Chapter 3, *Purpose and Need*, provides the purpose and need of the project and identifies the related project goals. Chapter 4, *Alternatives*, discusses the alternatives analysis conducted for the project. Chapter 5, *Affected Environment*, and Chapter 6, *Environmental Consequences*, present the existing conditions of human and environmental resources and the impacts that the Proposed Action may have on the resources, respectively, of the No-Build and Proposed Action alternatives. Chapter 7, *Project and Mitigation Commitments*, describes the proposed mitigation program to address adverse environmental impacts associated with construction and operation of the proposed Green Line Extension project. Chapter 8, *Section 4(f) Evaluation*, provides the required evaluation of the properties protected under United States Department of Transportation Act of 1966 (U.S. DOT Act), as amended,[9] within the project study area. Chapter 9, *Distribution List*, lists those agencies or persons consulted during the environmental review process, and those who have been notified of the release of this document.

9 *Section 4(f) of the United States Department of Transportation Act of 1966* (Amended March 12, 2008 in 73 FR 13395; implemented at 23 USC 138 and recodified at 49 United States Code, Subtitle I, Section 303(c)). Available at: http://www.gpo.gov/fdsys/pkg/FR-2008-03-12/pdf/E8-4596.pdf

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# 2

# Public Involvement and Agency Coordination

## 2.1 Introduction

The Green Line Extension project has received public input throughout the planning process. To plan and develop the project in coordination with the range of interests, the MassDOT established a public involvement process that included an Advisory Group, open public meetings, and coordination with the staff and elected officials of Cambridge, Somerville, and Medford, and other stakeholders. This process continued the public involvement that began in 2004, during the *Beyond Lechmere Northwest Corridor* study. The project website (www.mass.gov/greenlineextension) contains all of the materials used at the Advisory Group and public meetings, including comments and responses to comments, fact sheets, project updates, maps, and graphics. Table 2.1-1 provides a public involvement meeting summary.

### Table 2.1-1 Public Involvement Meeting Summary

| Meeting Type | Number of Meetings to Date |
|---|---|
| Project Advisory Group Meetings | 11 |
| Station Task Force Meetings[1] | 8 |
| Interagency Meetings | 35 |
| Neighborhood Group and Institution Presentations | 22 |
| Public Agency and Local Official Briefings | 60 |
| Public Meetings/Public Hearing[2] | 8 |
| Advisory Group Tutorials | 3 |
| Design Working Group Meetings | 2 |
| Station Design Workshops | 2 |

Table provides a subtotal of meetings held through December 7, 2010.

1 Attendance at these eight meetings was 83, 114, 98, 89, 74, 67, 76 and 91 respectively. Average 87.

2 Attendance at these seven public meetings was 138, 90, 320, 257, 69, 105, and 150 respectively. Attendance at the public hearing was 405. Average meeting attendance was 192.

NEPA Implementing Regulations at CFR Chapter 40, Section 1506.6 (40 CFR 1506.6), state that agencies shall:

- Make diligent efforts to involve the public in preparing and implementing their NEPA procedures.
- Provide public notice of NEPA-related hearings, public meetings, and the availability of environmental documents to inform persons and agencies who may be interested or affected.
- Hold or sponsor public hearings or public meetings whenever appropriate or in accordance with statutory requirements applicable to the agency.
- Solicit appropriate information from the public.
- Explain in its procedures where interested persons can get information or status reports on environmental impact statements and other elements of the NEPA process.
- Make environmental impact statements, the comments received, and any underlying documents available to the public pursuant to the provisions of the Freedom of Information Act (5 USC 552), without regard to the exclusion for interagency memoranda where such memoranda transmit comments of Federal agencies on the environmental impact of the Proposed Action.

MassDOT and the project team are committed to reaching out to the public and to disabled and environmental justice populations. The Green Line Extension project would bring major benefits of improved accessibility and mobility to numerous environmental justice neighborhoods located throughout the project study area. The team reached out to these communities to ensure their participation throughout the planning process and to achieve compliance with state and Federal guidelines.

This chapter describes the public involvement and agency coordination that have occurred through the various stages of the environmental review and planning process, which include:

- Before the DEIR/EA;
- The DEIR/EA Public Hearing;
- Since the DEIR/EA;
- The FEIR Public Meeting; and
- Since the FEIR.

## 2.2 Public Involvement before the DEIR/EA

Eleven Advisory Group meetings were held during preparation of the DEIR/EA, between September 2007 and August 2009. Two public meetings, attended by 226 people, were held in January and February 2008. Station workshops were held to obtain neighborhood input on station locations, access, and potential impacts and mitigation measures. Five station workshops were held in January and February 2008. A second round of public meetings was held in March 2009, in two different locations, which over 600 people attended. In addition to these meetings, the project team also attended numerous community and neighborhood briefings.

During this phase of the public involvement process, a number of key issues were raised involving technical analyses and project outreach including, but not limited to:

- **Ridership Modeling** – Based on requests for additional information by Advisory Group members, MassDOT held technical tutorials, conducted by CTPS, on ridership modeling.
- **Maintenance and Storage Facility** – Based on requests for additional information by Advisory Group members, MassDOT held a site tour of the Green Line Riverside southside maintenance facility and conducted a technical tutorial. Due to concerns about the proposed location of the northside support facility, MassDOT and the project team also produced a full study of the site selection process and evaluated numerous additional alternatives based on feedback and suggestions by members of the public.
- **Station Siting** – Early in the project, members of the Advisory Group and the public expressed interest in the siting of stations in the project study area neighborhoods. As a result, MassDOT held a series of five station workshops where members of the public could discuss their concerns in small groups with the project team about station siting, including locations of pickup/drop-off areas, platform locations, bicycle/pedestrian access, and ADA accessibility. Based on the feedback received at these meetings, some station locations received additional analysis and/or were reconfigured to address concerns raised by the public.
- **Tunnel Alignment Alternatives** – Several members of the public suggested constructing tunnels for segments of the Green Line Extension project. Based upon this interest, MassDOT and the project team performed an extensive analysis of tunneling as an alternative to at-grade construction. Ultimately, tunneling was found to be cost-prohibitive for this project.
- **Construction Impacts –** Members of the public expressed concerns about impacts during construction. MassDOT developed a detailed construction staging plan to help minimize the impacts to neighborhoods, including vehicular traffic, pedestrian traffic, on-street parking, public access, and emergency access to local businesses and residences.

MassDOT responded to requests for meeting materials in alternative formats, including audio tapes and large-print documents. These requests were in addition to the standard outreach approaches, including translating materials and meeting notices into multiple languages and other formats. Based on feedback from the public, MassDOT also expanded the project database by sending notices of the March 2009 public meetings to all property owners in Medford, Somerville, and Cambridge.

### 2.2.1 Project Advisory Group

MassDOT established a project Advisory Group of municipal officials, community representatives, and other interested individuals to help guide the public process, build consensus, and advise MassDOT on issues of concern. The members were recommended by the respective municipalities and appointed by the Secretary of Transportation.[1] The Advisory Group provided important guidance and input to MassDOT and the consultant team on a range of issues relating to the project.

The Advisory Group met approximately monthly throughout this process and served as the project's liaison to the community. Members reviewed information and advised on the preferred alternatives, station stops, and recommendations. Several members made independent recommendations as well. Advisory Group meeting presentations, materials, and summary meeting minutes were posted on the project website to keep the public apprised of issues that arose during meetings. All Advisory Group meetings were open to the public. Several meetings were filmed for local cable access broadcast.

MassDOT facilitated tutorial sessions for Advisory Group members to help them gain a deeper understanding of certain aspects of the project. Three tutorial sessions were offered during the summer of 2008: a ridership modeling presentation and discussion led by CTPS; a presentation and discussion of the proposed Community Path design; and a tour of the existing Riverside Green Line support facility with a presentation about the proposed maintenance and storage facility for the Green Line Extension project.

### 2.2.2 Agency Coordination

MassDOT facilitated 35 interagency meetings with Federal and state regulatory agencies, and over 60 public agency and local official briefings to guide the environmental review process. Meetings included representatives of:

- FTA;
- MBTA;
- Massachusetts Department of Conservation and Recreation (DCR);
- Massachusetts Department of Environmental Protection (MassDEP);
- MassDOT;
- EEA;
- MEPA;
- MHC;

1 The Advisory Group consisted of: Lee Auspitz, Davis Square Task Force; Paul Cote, appointed by City of Cambridge; William Deignan, City of Cambridge; Councilor Frederick DelloRusso, City of Medford; Rita Donnelly, appointed by City of Medford; Mimi Graney, Union Square Main Streets; Joe Guelpa, appointed by City of Somerville; David Jordan, appointed by City of Somerville; Kenneth Krause, appointed by City of Medford; Monica Lamboy, City of Somerville; Barbara Lucas, MAPC; Steve Mackey, Somerville Chamber of Commerce; Jim McGinnis, appointed by City of Somerville; Ellin Reisner, STEP/Green Line Forum; Barbara Rubel, Tufts University; Carrie Russell, Conservation Law Foundation; William Wood, appointed by City of Medford.

- CTPS;
- City of Cambridge;
- City of Somerville; and
- City of Medford.

## 2.2.3 Meetings

In addition to the project Advisory Group meetings and agency coordination, meetings facilitated by MassDOT throughout the environmental review process included general public meetings, station workshops, and briefings for neighborhood groups and institutions.

### General Public Meetings

Two public meetings were held in Medford in January and February 2008 to provide project background and context. Meetings included an open house for participants to talk with the project team, followed by a presentation and a question and answer session. Attendance was over 100 individuals at each meeting.

In March 2009, MassDOT held two public meetings in Somerville and Medford, presenting an overview of the project, an environmental analysis, recommendations for station sites, and the preferred project alignment. At both meetings, there was an open house, where the project team answered questions about the project. The meeting presentation, followed by a public question and comment period, lasted two hours. These meetings were advertised in local newspapers, sent to individuals on the project mailing list, and all residents of Somerville, Medford, and portions of East Cambridge received notices of the meetings. The distribution list for these meetings totaled approximately 37,000 individuals. Meeting notices were also translated into multiple languages including Spanish, Portuguese, and Haitian Creole. Approximately 258 individuals attended the Medford meeting, and 327 attended the Somerville meeting.

### Station Workshops

In January and February 2008, residents of Cambridge, Somerville, and Medford came to a series of five station workshops. MassDOT reached out to communities to help incorporate residents' everyday knowledge of the corridor into the analysis. The meetings began with an open house for participants to review maps of the corridor and talk with project team. Workshop-style sessions followed with participants providing input regarding station locations, station access, traffic intersections, pedestrian, bus, and bike path connections, and desired station amenities. The project team recorded participants' comments, while participants completed worksheets for the project team to review.

Individuals on the project mailing list were sent notices of these meetings, and abutters to the proposed station locations received flyers about the meetings. Flyers in multiple languages were also distributed at nearby commuter rail and Orange Line stations. Flyers in multiple languages were sent to area libraries and city clerks' offices for posting.

#### Briefings for Neighborhood Groups and Institutions

MassDOT has attended over 20 meetings with targeted neighborhood groups, upon request of the group. The project team gave brief presentations at the neighborhood meetings and for the disability communities (municipal disability commissions and the MBTA Access Advisory Committee) in Cambridge, Somerville, and Medford.

### 2.2.4 Website

MassDOT established an interactive project website in November 2007 (www.mass.gov/greenlineextension). Along with a brief overview of the project's history and current phase, the website provides access to various reference materials, including documents from previous phases of the project as well as the most up-to-date project materials. Interested individuals are also able to sign up to be on the project mailing list. Individuals are also able to post comments about the project publicly as well as use the website to ask questions of MassDOT and the project team. Materials from the project website have been converted into audio tapes upon request from members of the public

### 2.2.5 Written Materials

The project team has provided project meeting minutes and fact sheets to the 1,967 individuals listed in the Green Line Extension project database, and posted these documents to the project website.

#### Summary Meeting Minutes

The project team provided summary minutes of every MassDOT-hosted meeting, including public meetings, Advisory Group meetings and tutorials, and agency briefings. These notes highlighted the presentation, key issues raised, and participants' concerns. They are posted on the website and printed versions are available in different formats upon request.

#### Fact Sheets

The project team prepared one fact sheet in advance of the January/February 2008 public meetings to outline the issues and options under review and indicate how and when comments can be shared or submitted. The project team also prepared an additional fact sheet and frequently asked questions (FAQs) sheet in advance of the March 2009 public meetings. The fact and FAQ sheets were posted to the project website and are available in multiple languages as well as in a large-print, text-only version.

The project team prepared another fact sheet in advance of the DEIR/EA release in the Fall of 2009. The DEIR/EA fact sheet outlined the contents of the DEIR/EA, provided a summary of project impacts, project cost and funding, an overview of project components, and information on providing comments on the DEIR/EA.

### 2.2.6 Outreach to Environmental Justice and Disabled Populations

MassDOT and the project team are committed to reaching out to environmental justice and disabled populations. The Green Line Extension project would bring the benefits of improved accessibility and mobility to numerous environmental justice neighborhoods located along the project corridor. The team reached out to these populations to ensure their participation in the environmental review process and to achieve compliance with state and Federal guidelines.

The majority of the Advisory Group meetings were covered by local cable television stations to ensure that individuals could view the proceedings even if they were not able to attend the meetings in person. Meeting presentations and minutes were transcribed onto audio tape on behalf of the visually impaired at the request of participants.

The station workshops were held in neighborhoods with environmental justice populations, and flyers advertising these workshops and other meetings were distributed at Orange Line and local bus stops in Spanish, English, and Portuguese. These flyers were also distributed door-to-door to potential abutters to the stations (both residential and business) in advance of the meetings. MassDOT used local media for press announcements and paid advertisements of these meetings. At the public meetings and station workshops, interpreters were also available upon request for participants. All English-language meeting announcements included a statement in Spanish, Portuguese, and Haitian Creole offering to translate the announcement.

The project fact sheet was translated into Spanish and English. A large-print fact sheet was developed for the visually impaired. These materials were distributed at public meetings, on the project website and upon request. Audio equipment was employed at all meetings to accommodate hearing impaired members of the community.

Environmental justice issues were discussed in numerous meetings with community planning and elected officials. The project team also met with many neighborhood and community organizations to provide project briefings to community members and listen to their concerns. These organizations included the Disability Commissions in Cambridge, Somerville, and Medford.

The project database includes multiple community, neighborhood, and environmental justice organizations in the three affected communities. Meeting announcements for the final set of public meetings were mailed to all residents of the neighborhood of East Cambridge in Cambridge, as well as the municipalities of Somerville and Medford, to assure the widest possible outreach to environmental justice residents.

## 2.3 DEIR/EA Public Hearing

The DEIR/EA was released in October 2009 for public review and comment. MassDOT hosted a public hearing for the DEIR/EA, attended by over 400 people, in November 2009. The approximately 400 comment letters (with more than 2,400 individual comments) on the DEIR/EA reflect a substantial interest in the future of the corridor from elected officials and municipal representatives; city, state, and regional agencies; environmental, bicycle, and pedestrian advocacy groups; neighborhood groups; groups that represent the disabled; businesses; residents; and the general public. Responses were prepared for over 2,400 individual comments on the DEIR/EA (provided in Appendix A, *FEIR Responses to Comments on the DEIR/EA*), of this EA.

During the public hearing and in the DEIR/EA comment letters, a number of key concerns and issues were raised. Those concerns and issues, as well as general responses, are summarized below:

- **Station Design –**The greatest number of station design comments focused on the relocated Lechmere Station (approximately 200 comments). Concerns included the location of the track near the Brickbottom Artists Building; parking at the station; bus circulation and bus stop locations; the pedestrian crossing at Monsignor O'Brien Highway/Route 28; and general station layout, access, and architectural character. Several comments expressed support for adaptive reuse of parts of the existing Lechmere Station, particularly the bus shed. Several comments requested reconsideration of the Mystic Valley Parkway/Route 16 station layout and its inclusion in the Proposed Action.

  ***Response:*** *The conceptual design for the relocated Lechmere Station presented in the DEIR/EA was revised as a result of public comments. The Lechmere Station parking program, station layout, and roadway configuration were each modified, as presented in the FEIR and this EA. Formal pickup/drop-off locations were provided at all stations. The location of Washington Street Station has also been revised based on community input. All station designs would be further refined as the project progresses through the design process, based upon a combination of ridership projections; physical, engineering, and* *financial constraints; and community input. The PIP*[2] *explains how community input into station design would be sought during the design process.*

- **Access –** Comments expressed general support for prioritizing pedestrian, bicycle, and bus access to the project stations. Members of the public were concerned with locations of pickup/drop-off areas and their impacts on traffic; platform locations; bicycle/pedestrian access; and ADA accessibility at station approaches, within the stations, and between the platforms and vehicles.

  ***Response:*** *MassDOT and the MBTA are committed to intermodal transportation and integrating the needs of pedestrians (including disability populations), bicycle, and automobile users of the transit system. As the design phase progresses, the stations would be designed to the extent practical to provide appropriate access for the anticipated riders at each site, taking into consideration operational needs, physical and financial constraints, and legal requirements. As noted above, the revised Lechmere Station design incorporates some of these considerations now.*

- **Maintenance and Storage Facility –** Members of the public were concerned with the location of the maintenance and storage facility. Of all comments received, the majority (including over 225 petition signatures) opposed the siting of the light rail facility at Yard 8. Most commentors were in favor of the Option L site. Lechmere Station-area stakeholders expressed general opposition to the Mirror H location, while Somerville stakeholders generally preferred Mirror H but also welcomed Option L.

  ***Response:*** *An extensive evaluation of the maintenance and storage facility has been conducted for the project. In December 2009, a public meeting was held and subsequently Option L was identified. The Option L site was selected as the preferred location as it best balances operational needs, environmental benefits and impacts, and received the greatest support from the local communities. The maintenance and storage facility alternatives analysis and environmental analysis are available on the project website at www.mass.gov/greenlineextension.*[3]

- **Continued Coordination with Agencies and Interested Parties –** Members of the public requested that MassDOT and MBTA continue public involvement during design and construction. Several requested a construction field office where stakeholders could speak directly with project representatives regarding construction impacts and mitigation.

  ***Response:*** *A PIP has been developed to describe how MassDOT and the MBTA would continue coordination with agencies and interested parties. The PIP includes public information meetings; community meetings, briefings, and presentations; a Green Line*

2 Massachusetts Department of Transportation. *Final Environmental Impact Report (Volumes 1, 2 and 3). Chapter 6 - Public Involvement Plan*. Prepared by Regina Villa Associates and Vanasse Hangen Brustlin, Inc., June 2010. Available at: http://www.greenlineextension.org/docs_finalEIR.html.

3 Massachusetts Department of Transportation. *Green Line Extension Project, Additional Maintenance Facility Alternatives Analysis Technical Memorandum.* December 9, 2009 and *Green Line Extension Project, Environmental Analysis of Additional Maintenance Facilities Technical Memorandum.* April 21, 2010. Both available on the project website at: www.mass.gov/greenlineextension.

*Extension Design Working Group; workshops; and broadly distributed communication methods such as the project website, fact sheets, electronic communications, and media outreach.*

- **Alternatives –** Members of the public were predominantly in favor of the Proposed Action. A large number of comments requested that the project continue to Mystic Valley Parkway/Route 16 in one phase. Few expressed support for a College Avenue terminus of the Medford Branch. Approximately 70 comments expressed concern about traffic and neighborhood parking impacts at College Avenue. Several other comments expressed concern that the College Avenue terminus would not adequately serve Medford Hillside residents. Approximately 50 commentors requested that the project not preclude future extensions or additions of the Green Line. Most of these comments supported a future extension of the Union Square Branch to Porter Square; several commentors supported a possible future station on one or both branches near the Brickbottom Artists Building and/or Boynton Yards.

  ***Response:*** *Funding is not currently available to advance the Green Line to Mystic Valley Parkway/Route 16, although that remains MassDOT and the MBTA's goal for Phase II of the Green Line Extension project. The impacts to traffic and neighborhood parking that would result from the College Avenue Station, and measures that would be taken to mitigate those impacts, are further explained in this EA. To the extent practical, the project design would allow for future expansion of the Green Line.*

- **Mitigation –** Members of the public were concerned and/or interested with proposed mitigation measures for potential impacts from increases in noise, vibration, or traffic, and the maintenance and storage facility. A large number of comments pertained to noise, vibration, and visual impacts at the Glass Factory Condominiums near the relocated Lechmere Station. Most of the comments from Brickbottom Artists Building stakeholders expressed concern about noise and visual impacts of a maintenance and storage facility at Yard 8; others expressed concern about impacts from railroads and proposed light rail along the south side of the Brickbottom Artists Building.

  ***Response:*** *Specific traffic and noise and vibration mitigation are identified in this EA. Mitigation measures would be finalized during the design process and would be implemented in accordance with regulatory requirements. Chapter 7, Project and Mitigation Commitments, of this EA outlines preliminary mitigation measures.*

- **Community Path –** Members of the public requested that the design and construction of the Somerville Community Path be included in the Green Line Extension project (over 125 comments and 175 petition signatures). Many of these comments requested that the Path extend to Lechmere Station as part of the project.

  ***Response:*** *MassDOT is committed to developing the final design plans for the proposed extension of the Somerville Community Path between Lowell Street and Inner Belt Road. MassDOT would continue to work with the City of Somerville to identify state and*

*Federal funding opportunities for the environmental review process and construction of the Community Path.*

- **Construction Impacts –** Members of the public expressed concerns with regard to impacts during construction, including noise and vibration, vehicular traffic, detours during bridge reconstruction, pedestrian traffic, on-street parking, public access, and emergency access to local businesses and residences.

  ***Response:*** *Construction period mitigation was developed to prevent or reduce construction impacts, as summarized in Chapter 7, Project and Mitigation Commitments, of this EA. This mitigation would be refined as the project design progresses, and would be selected recognizing community concerns, physical and financial constraints, legal requirements, and practicality. MassDOT is committed to prepare a detailed plan to address various construction period impacts through coordination with cities and appropriate emergency personnel prior to construction. MassDOT would also work with contractors to establish construction protocols to ensure that mitigation strategies are properly implemented.*

## 2.4 Public Involvement since the DEIR/EA

Additional public involvement activities have occurred since the release of the DEIR/EA and during the preparation of the FEIR. These activities included a public meeting in December 2009 to release the results of the operational analysis on the maintenance and storage facility alternatives; various meetings with community groups, local businesses and institutions, municipal representatives from Cambridge, Somerville, and Medford and Federal agencies; developing a comprehensive PIP and holding Land Use Planning Workshops in May and June 2010. A summary of the PIP is provided in Section 2.6, *Public Involvement Since the FEIR*, of this chapter.[4] Since the release of the DEIR/EA:

- MassDOT held one public meeting in Cambridge in December 2009 to present the Option L and Mirror H alternatives for siting, design, and construction of a Green Line vehicle maintenance and storage facility. Yard 8, as fully analyzed in the DEIR/EA, was also presented for comparison purposes. The meeting included a presentation by MassDOT and a question and answer session. The presentation provided an overview of the operational analysis, property acquisition needs, and schedule implications, as well as a preliminary evaluation of potential environmental impacts and costs of the three sites under consideration. Attendance was more than 125 people.
- MassDOT held numerous briefings for community groups, local businesses and institutions, municipal representatives and Federal agencies. Beginning in March 2010, MassDOT and the project team have met monthly with municipal leaders of the corridor communities. These meetings focused on a wide range of

4 Massachusetts Department of Transportation. *Final Environmental Impact Report (Volumes 1, 2 and 3). Chapter 6 - Public Involvement Plan*. Prepared by Regina Villa Associates and Vanasse Hangen Brustlin, Inc., June 2010. Available at: http://www.greenlineextension.org/docs_finalEIR.html.

project-related issues, including developing the public involvement approach for the preliminary engineering phase of work and planning the Land Use Planning Workshops for May and June 2010.

- MassDOT, working with the local municipalities, hosted a series of Land Use Planning Workshops associated with the Green Line Extension project. After an overview presentation about the Green Line Extension project, participants were given a chance to share knowledge about their neighborhoods and to express their priorities and concerns about future land uses around the station areas. These workshops focused on areas around the planned stations, with the intention that future workshops would focus on the stations themselves. Workshops were held in Medford on May 19, 2010, in Cambridge on May 26, 2010, and in Somerville on June 12, 2010. There were 69, 79, and 92 people in attendance, respectively.
- MassDOT and the project team are committed to reaching out to environmental justice populations. The team sent notifications to these populations to ensure their participation throughout the NEPA process. Section 6.4, *Environmental Justice*, of this EA describes the outreach to environmental justice populations in detail.

The public meetings were publicized through a variety of means including newspaper advertisements, website postings, press releases in multiple languages, citywide mailing, email distributions, and postcard mailings to a database of over 4,500 people who have attended meetings, requested information, signed up online, written a comment letter, talked to a staff member, or are abutting property owners to the Green Line Extension project.

MassDOT continually updates the project website, www.mass.gov/greenlineextension, with new information as it becomes available. A project blog page is also maintained and provides periodic updates of project information.

Since the release of the DEIR/EA, MassDOT has sent weekly emails to more than 2,000 individuals on its project email distribution list concerning on-going data collection efforts, which include survey and geotechnical investigations.

The project team prepared an additional project fact sheet in advance of the FEIR release in June 2010. The FEIR fact sheet outlined the anticipated content of the FEIR, discussed ongoing survey work and data collection that would be used to advance the design of the Green Line Extension project, and discussed the public workshops on station area land use planning and station design.

## 2.5 FEIR Public Meeting and Comments

The FEIR was released in June 2010. The FEIR is a state environmental review document required by MEPA, and not subject to review by the FTA. The public meeting for the FEIR, attended by over 150 people, was held by MassDOT in June 2010. This meeting, combined with the approximately 450 comment letters on the FEIR, reflected continued substantial public interest in the project. A number of key concerns and issues were raised. Those concerns and issues, as well as general responses to these comments, are summarized below.

- **Station Design and Location Comments:** Members of the public continue to be concerned with station design and location issues. The greatest number of comments were about the new Washington Street Station and the relocated Lechmere Station. Commentors generally requested more details of station design on a range of issues, including parking at the stations; bus circulation and bus stop locations as well as integration with existing bus service; the relocated Lechmere Station's pedestrian crossing at Monsignor O'Brien Highway/Route 28; and general station layout. Several commentors suggested that the Brickbottom Station (now referred to as the Washington Street Station) would be better located at Washington Street than on Joy Street. Several comments expressed support for redevelopment rather than demolition of the existing Lechmere Station.

  ***Response:*** *Station designs would be further refined as the project progresses through the design process, based upon a combination of ridership projections; physical, engineering, and financial constraints; and community input. Station locations have been selected based on these parameters as well as geographic considerations such as spacing, land acquisition requirements, and physical relationship to other transportation infrastructure. Since the release of the FEIR, further refinements have been made to the Lechmere Station based on local input. The Brickbottom Station has been relocated to the corner of Washington Street, and renamed the Washington Street Station, based on the input from the local community.*

- **Access Comments:** Stakeholders requested prioritizing pedestrian, bicycle, and bus access at the project stations. Members of the public were concerned with locations of pickup/drop-off areas and their impacts on traffic; platform locations; bicycle/pedestrian access; and ADA accessibility at station approaches, within the stations, and between the platforms and vehicles.

  ***Response:*** *MassDOT and the MBTA are committed to intermodal transportation and integrating the needs of pedestrian, bicycle, and automobile users of the transit system. As the design phase progresses, the stations would be designed to the extent practical to provide appropriate access for the anticipated riders at each site, taking into consideration operational needs, physical and financial constraints, and legal requirements. As* *described in the PIP, community input on station design would be sought during the design process.*

- **Maintenance and Storage Facility Comments:** Members of the public were consistently in favor of locating the maintenance and storage facility at the Option L site, but generally requested additional details about the site design (including mitigation).

  ***Response:*** *Option L was selected by MassDOT as the preferred site for the maintenance and storage facility in part due to the level of support from the public and local municipal officials. MassDOT would continue to seek input from the public on design issues related to the Green Line Extension project vehicle maintenance and storage facility. However, similar to station design, many elements of the maintenance and storage facility would be designed based on MBTA operational guidelines and requirements, physical and financial constraints, and mitigation considerations.*

- **Public Involvement Plan Comments:** Members of the public expressed appreciation for the proposed PIP and requested that MassDOT and the MBTA proactively seek public involvement during design and construction.

  ***Response:*** *MassDOT and the MBTA would continue to work with regulatory agencies, municipalities, other organizations, and the general public in the forums described in the PIP: public information meetings; community meetings, briefings, and presentations; a GLX Design Working Group; workshops; and broadly distributed communication methods such as the project website, fact sheets, electronic communications; and media outreach. The project team would coordinate with other ongoing and forecasted projects and specifically reach out to environmental justice and disabled populations.*

- **Alternatives:** Members of the public were predominantly in favor of the Green Line Extension project. With few exceptions, the public requested that the project continue to Mystic Valley Parkway/Route 16 in one phase. Several commentors expressed concern that the College Avenue terminus would neither adequately serve Medford Hillside residents nor comply with the SIP. Other commentors requested that the project not preclude future extensions or additions of the Green Line. Most of these comments supported a future extension of the Union Square Branch to Porter Square.

  ***Response:*** *As described in the FEIR, funding is not currently available to advance the Green Line to Mystic Valley Parkway/Route 16, although that remains MassDOT and the MBTA's goal for Phase II of the Green Line Extension project. MassDEP has concluded that the terminus at College Avenue Station complies with the SIP.*

- **Mitigation/Section 61 Findings Comments:** Members of the public were concerned about proposed mitigation measures for potential impacts from noise, vibration, traffic and parking, and the maintenance and storage facility. Additional details of mitigation measures were requested. Recommendations were made to provide mitigation measures at the start, rather than end, of the construction phase. A large number of comments pertained to increased noise and vibration at the Glass Factory Condominiums near the proposed Lechmere Station. Brickbottom Artists Building stakeholders continued to express concern about noise and vibration impacts of a maintenance and storage facility; others expressed concern about noise and vibration impacts from railroads and proposed light rail along the south side of the Brickbottom Artists Building. Many of these commentors requested that tracks for the commuter rail trains be moved farther from the Brickbottom Artists Building as a measure to minimize air quality impacts from diesel-powered trains, as well as a reduction of tracks from five to four. Some commentors expressed specific concern about the adverse impacts of noise and vibration on health and on the lifestyle of residential abutters.

***Response:*** *The track alignment in the vicinity of the Brickbottom Artists Building has been revised to avoid and minimize noise, vibration, and visual impacts to the extent feasible. Mitigation for operational period impacts would be specifically identified as the project design progresses, and would be selected recognizing community concerns, physical and financial constraints, legal requirements, and practicality. The selected measures would be implemented before, during, or after the construction phase as appropriate based on logical construction sequencing.*

- **Community Path:** Members of the public requested that the design and construction of the Somerville Community Path be included in the Green Line Extension project. Over 60 percent of the comment letters expressed support for the Community Path.

  ***Response:*** *MassDOT is committed to completing all planning, design, and engineering work - including the identification of necessary property acquisitions - for the proposed extension of the Somerville Community Path between Lowell Street and Inner Belt Road. MassDOT would continue to work with the City of Somerville to identify state and Federal funding opportunities for the construction of the Community Path.*

- **Construction Impacts:** Members of the public expressed concerns with regard to environmental and social impacts during construction, including noise and vibration, vehicular traffic, detours during bridge reconstruction, pedestrian traffic, on-street parking, public access, and emergency access to local businesses and residences. Details regarding mitigation measures for these construction impacts were commonly requested.

  ***Response:*** *Mitigation measures for construction impacts are summarized in Chapter 7, Project and Mitigation Commitments, of this EA. As with the operational period mitigation measures described above, construction period mitigation measures would be refined as the project design progresses, and would be selected recognizing community concerns, physical and financial constraints, legal requirements, and practicality. The selected measures would be implemented before, during, or after the construction phase as appropriate based on logical construction sequencing. As described in the PIP, an Ombudsman would act as community liaison to hear and resolve community complaints during construction.*

## 2.6 Public Involvement since the FEIR

Public involvement activities that have occurred since the FEIR include the creation of a Design Working Group for later phases of the project, station workshops, community briefings and meetings with local officials, Section 106/Section 4(f) Consultation Sessions, and implementation of the PIP. The project team has made presentations and gathered public input from groups in the project study area communities when invited.

### 2.6.1 GLX Design Working Group

As part of the planning for the preliminary engineering phase, MassDOT convened a GLX Design Working Group. This group is assisting MassDOT by reaching out to local residents, businesses, and institutions to gather input on the design of six new stations proposed for the neighborhoods of in the vicinity of Washington Street, Gilman Square, Lowell Street, Ball Square, College Avenue, and Union Square, as well as the relocation of Lechmere Station. In addition, MassDOT is seeking public input on design issues related to the Green Line Extension vehicle maintenance and storage facility.

On April 1, 2010, MassDOT distributed an application for membership on the GLX Design Working Group to individuals on the project database and announced its availability in local newspapers and libraries. Applications were accepted until April 30, 2010. More than 100 applications were received, and the project team interviewed a final list of potential participants. MassDOT announced the members of the GLX Design Working Group prior to the filing of the FEIR. The list of members is available on the project website.

The first meeting of the GLX Design Working Group was held on August 9, 2010 to provide an overview on the current status of the design work and the schedule for preliminary engineering, and to seek ideas on the fall station design workshops. There were 46 people in attendance. Several members of the public spoke during the public comment period at the end of the meeting.

The second meeting, held November 8, 2010, presented a project update by the MBTA on the palette of materials that would be used for station design. The Metropolitan Area Planning Council (MAPC) also presented an update on the Route 16 Study. Meetings would be scheduled as needed. Because the GLX Design Working Group members have a strong interest in many elements of the project, subcommittees have also been formed (in accordance with the Commonwealth's Open Meeting regulations) to explore topics in depth, including draft Community Design Principles. The meetings are advertised throughout the project study area and the public is welcome to attend. A comment period is available at the end of each meeting. The GLX Design Working Group would continue to convene on a quarterly basis throughout the preliminary engineering phase of the project.

### 2.6.2 Station Design Workshops

Two educational public workshops were held on September 28 and 29, 2010 in Somerville and Medford, respectively, to outline the guidelines and requirements used by the MBTA to design successful stations. These goals include accessibility, maintainability, safety/personal security, sustainability, and integration with the neighborhood. The MBTA presented the five elements of the MBTA's station program, which include passenger circulation, public spaces, station elements, MBTA rooms, and station priorities. Several members of the public provided verbal and written comments during each interactive workshop. A total of 171 people attended.

### 2.6.3 Section 106 Consultation Sessions

Pursuant to Section 106 of the NHPA and 49 U.S. Code Section 303,[5] MassDOT held two consultation sessions on October 1 and 13, 2010 to assist in the completion of these processes. The following stakeholders were invited to participate:

- MHC;
- The Boston Landmarks Commission (BLC);
- The Cambridge Historical Commission;
- The Somerville Historic Preservation Commission; and
- The Medford Historical Commission (non-participating).

The October 1, 2010 consultation session focused on the development of the Area of Potential Effect (APE) and the inventory of historical resources identified within the APE. The October 13, 2010 consultation session focused on the effects of the Green Line Extension project on identified historic properties and proposed mitigation.

An additional consultation session was held on December 9, 2010 to discuss potential sensitive archeological resources with the Massachusetts Commission on Indian Affairs, the Mashpee Wampanoag Tribe, and the Wampanoag Tribe of Gayhead/Aquinnah.

Additional information on the Section 106 process is discussed in Section 5.15, *Cultural Resources,* and Section 6.13, *Cultural Resources,* of this EA. The complete Section 4(f) Evaluation is provided in Chapter 8, *Section 4(f) Evaluation*, of this EA.

5 Formerly known as Section 4(f) of the Department of Transportation Act of 1966, and commonly referred to as Section 4(f).

### 2.6.4 Continued Public Involvement through Design and Construction

In partnership with the MBTA, MassDOT would continue public outreach through a PIP. The PIP would guide outreach through the design, engineering, and construction of the Green Line Extension project.

MassDOT expects that members of the public are likely to comment on a number of topics. While MassDOT welcomes this input, building and operating the transit system safely must remain the responsibility of MassDOT and the MBTA. Final determination of many elements of the transit system is guided by regulation and established practice. In these cases, the project team would provide relevant explanations for policies and decisions.

As stated in the PIP,[6] MassDOT and the MBTA plan to continue and enhance effective outreach strategies and hope to involve new stakeholders and interests in the design review. The methods for this engagement include:

- Public information meetings, community briefings, meetings and presentations;
- GLX Design Working Group;
- Design public workshops;
- Updates on the project website;
- Project fact sheets and information materials;
- Email notifications, communication, and media outreach; and
- Outreach to environmental justice populations.

MassDOT and the MBTA are committed to continuing a robust public involvement process during the construction of the Green Line Extension project. Strategies would a) inform the public of construction plans, b) provide regular updates on construction, traffic detours and other impacts, and c) solve problems that arise during construction. The Green Line Extension project construction contractor would be required to commit to a spectrum of outreach activities and efforts to mitigate the impacts of construction. MassDOT and the MBTA would hold the construction contractor to these obligations. Working together, agency and contractor staff members would be dedicated to implementing these communication and problem-solving strategies. Key elements of the construction outreach plan include:

- Establishing a project construction office;
- Establishing the position of Green Line Extension project Ombudsman who would field all construction-period comments and complaints, coordinate with the cities, and respond to public concerns;

6 Massachusetts Department of Transportation. *Final Environmental Impact Report (Volumes 1, 2 and 3). Chapter 6 - Public Involvement Plan*. Prepared by Regina Villa Associates and Vanasse Hangen Brustlin, Inc., June 2010. Available at: http://www.greenlineextension.org/docs_finalEIR.html.

- Establishing a Construction Working Group to advise MassDOT and the MBTA;
- Establishing a project email address and 24-hour phone hotline for public concerns;
- Providing frequent website updates of construction activities at www.mass.gov/greenlineextension;
- Hosting neighborhood construction kick-off meetings;
- Producing quarterly construction updates; and
- Developing a business outreach plan to assist local businesses during construction.

MassDOT and the MBTA have reviewed these communication and outreach plans in light of comments received on the MEPA process; new ideas or proposals from the GLX Design Working Group, communities, or individuals; and information that arises during the preliminary engineering phase. As always, MassDOT and the MBTA are committed to public outreach strategies that reflect the phase of the project, that provide all interested individuals with an opportunity to give input and ask questions, and that assist the project team in its plans and designs for the Green Line Extension project.

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# 3

# Purpose and Need

This chapter defines the purpose of and need for the Green Line Extension project and identifies a number of related project goals.

## 3.1 Project Purpose

Traffic congestion, mode transfer, and service delays hamper access from the project study area to downtown Boston, as well as to jobs and services within the project study area. The Purpose of this project is to improve mobility within the project study area, boost transit ridership, improve regional air quality, ensure equitable distribution of transit services, and support opportunities for smart growth initiatives and sustainable development.

## 3.2 Project Study Area

The project study area is generally bounded by Interstate 93 (I-93) and the MBTA Orange Line to the east, the MBTA Red Line and MBTA Fitchburg Line commuter rail right-of-way to the west and south, and the MBTA West Medford commuter rail station to the north. This area includes east Cambridge and portions of Somerville and Medford. The area consists of densely settled urban corridors with a large base of commuters and transit users, but is currently underserved by fixed-guideway transit. Figure 1.1-1 shows the project study area for the Green Line Extension project.

With approximately 18,870 people per square mile in Somerville, 15,760 in Cambridge, and 6,850 in Medford, the project study area neighborhoods are among the densest in the Boston region.[1] In addition, approximately 60 percent of the residents of Cambridge, Somerville, and Medford live in state-defined environmental justice areas, which comprise approximately 42.8 percent of the cities' combined

1 United States (U.S.) Census Bureau, *Census 2000*. Available at http://www.census.gov.

area.[2] The region is currently underserved by transit, and 2000 United States (U.S.) Census data indicate that approximately 26 percent of project study area households do not own a vehicle, which can create a need for reliable and efficient transit service. In addition, roadway congestion in the project study area impacts the reliability of current on-street transit services and results in lengthy travel times. For example, one route paralleling the proposed Medford Branch takes approximately 26 minutes to travel the 3.4-mile distance between Lechmere Station and College Avenue.

## 3.3 Need for Transit Improvements

The Commonwealth of Massachusetts, in obtaining environmental permits and approvals for the Central Artery/Tunnel project in the early 1990s, committed to a number of transit improvement projects in the Boston region as mitigation measures. The transit project commitments included a Green Line Extension to Medford Hillside. The Green Line Extension project is also a requirement of the Massachusetts Air Quality Regulations (310 Code of Massachusetts Regulations [CMR] 7.36), which implement the SIP, and require that MassDOT complete the project by December 31, 2014. Due to the time required to collaborate with the communities surrounding the Green Line Extension project corridor regarding the preferred vehicle maintenance and storage facility site and other project-related issues, it is anticipated that the Proposed Action would be completed in June 2019. Selection of an interim emission reduction offset project and measures (as required by the SIP) are forthcoming to achieve emission reductions equal to or greater than the emission reductions that would have been achieved had the project not been delayed by nearly one year.

Transit improvements are needed along the Green Line Extension project corridor as a result of:

- Poor transit access and mobility;
- Limited transit capacity;
- Poor regional air quality; and
- Traffic congestion on local roads.

Existing transit service within the project study area is currently offered by 15 MBTA bus routes. These routes provide access points within the project study area communities and connect to Boston and suburban Arlington, Woburn, and Winchester. However, these bus routes operate in mixed-flow traffic along congested streets, which causes inefficient and unreliable transit service delivery in the project study area. Although MBTA commuter rail lines travel through the project study area, there are no commuter rail stops to provide the benefit of rail access. Deficient

2 Environmental justice areas are defined by thresholds for income, minority populations, foreign-born populations, and English proficiency. Therefore, most environmental justice areas contain a mix of environmental justice and non-environmental justice residents.

transit mobility and access in the project study area is more fully described in the following sections.

### 3.3.1 Transit Access and Mobility

The project study area neighborhoods are among the densest in the Boston region. Somerville is ranked among the densest cities in the U.S. and is the densest city in Massachusetts, with approximately 18,870 people per square mile; Cambridge ranks number three at roughly 15,760 people per square mile; and Medford number 18 at roughly 6,850 people per square mile. By way of comparison, the City of Boston ranks number four in Massachusetts with a population density of approximately 12,170 people per square mile.[3]

Cambridge is well-served by transit, with one MBTA Green Line station (Lechmere), five MBTA Red Line stations, and one MBTA commuter rail station (Porter Square). Somerville is served by one MBTA Red Line station (Davis Square) and one MBTA Orange Line station (Sullivan Square), but these are located at the periphery of the City and do not serve the dense population within the project study area. Medford has one commuter rail station (West Medford) and one MBTA Orange Line station (Wellington). These stations are peripheral to Medford and poorly serve the population.

Transit services that currently operate in the project study area provide inadequate links between centers of activity including commercial districts, private and public colleges and universities, medical and cultural facilities and downtown Boston. These access constraints adversely affect employment opportunities for residents within both the project study area and greater region. Although the City of Boston provides employment opportunities at all income levels, access to jobs by personal automobile or public bus in Boston is constrained by the congested roadways and lengthy travel times to the downtown core. The lack of easy connections to alternative transit modes in parts of the project study area makes it necessary for transit patrons to make multiple transfers to reach jobs in Boston. Improvements to transit services would make public transportation a more compelling travel choice by reducing transit travel times throughout the project study area and to downtown Boston.

The growth of area institutions is also constrained by the limitations of the transportation system. Improved transit services would make economic, educational, medical, and recreational opportunities within the project study area and the region more accessible to households within the project study area.

3 U.S. Census Bureau, *Census 2000*. Available at http://www.census.gov/

### 3.3.2 Transit Capacity and Service Quality

Existing bus service in the project study area accommodates an average of 35,635 weekday daily riders.[4] However, the existing bus network suffers from poor reliability and service quality. According to the MBTA's Summary Analysis of Routes and Recommended Changes in the *Fall 2008 Service Plan*, all project study area bus routes except the Route 85 failed to meet the Schedule Adherence Standards.[5]

Project study area congestion and right-of-way constraints severely limit the reliability and capacity of the bus network in the project study area. Congestion in the corridor contributes to the inability of existing bus service to meet MBTA standards for service delivery, which could be attributed to or exacerbated by the fact that 21 project study area intersections experience a failing level of service (LOS) during at least one of the peak hours, which adds to the delay incurred by existing bus operations. Bus service performance is also affected by the corridor's narrow streets, on-street parking, and numerous intersections, all of which create considerable delay for buses and other vehicles. MBTA buses that travel within the flow of traffic average nine miles-per-hour through the corridor, based on the current bus schedule and current bus stops.

### 3.3.3 Air Quality

The Proposed Action is located within an area designated non-attainment for ozone air quality standards by the U.S. Environmental Protection Agency (EPA), with a classification of "moderate." Motor vehicles, including local trucks, are the predominant sources of ozone precursor emissions within the project study area. In order to reduce vehicle miles traveled (VMT) and consequently cut emissions of volatile organic compounds (VOCs) and carbon monoxide (CO), transit options within the project study area must improve. This would promote a shift in travel mode from automobiles. As previously mentioned, the Proposed Action is a requirement of the Massachusetts Air Pollution Control Regulations (310 CMR 7.36) implementing the SIP, which conforms to Federal air quality standards.

### 3.3.4 Sustainable Development/Smart Growth

The project study area presents opportunities for economic development around transit centers. Introducing enhanced transit, undertaken in coordination with smart growth-based local land use planning, may support Commonwealth goals in promoting concentrated mixed-use development and revitalizing urban centers.

4 Massachusetts Bay Transportation Authority. *Ridership and Service Statistics (Blue Book, Twelfth Edition)*, 2009. Available at: http://www.mbta.com/uploadedfiles/documents/Bluebook%202009.pdf

5 Massachusetts Bay Transportation Authority. *Final 2008 Service Plan Bus, Rapid Transit, and Boat Service Changes and Service Delivery Policy Modifications*, Fall 2008. Available at: http://www.mbta.com/uploadedFiles/About_the_T/T_Projects/T_Projects_List/ServicePlan08.pdf

There are a number of local development plans or master plans that are being undertaken by the communities in the project study area, including transit-oriented developments (TOD) such as NorthPoint and the Archstone-Smith residential development adjacent to Lechmere Station. Any transportation investment undertaken by the Commonwealth must be coordinated with local land use policies and regulatory structures that support smart growth aims of expanding the region's housing supply and employment base, concentrating development, and protecting environmental resources.

### 3.3.5 Environmental Justice

The project study area for the Green Line Extension project contains environmental justice populations. Approximately 42.8 percent of Cambridge, Somerville, and Medford are defined as environmental justice areas, which contain approximately 60 percent of the residents of the three cities.[6] Executive Order 12898, *Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations*, requires specific examination of environmental and human health effects on minority populations and low-income populations to ensure that these populations are not disproportionately impacted by Federal projects. The U.S. DOT Order 5610.2 on environmental justice defines a disproportionately high effect on minority and low-income populations as "an adverse effect that is predominately borne by minority population and/or a low-income population; or will be suffered by the minority population and/or low-income population and is appreciably more severe or greater in magnitude than the adverse effect that will be suffered by the non-minority population and/or non low-income population."

Alleviating the burden on environmental justice populations, outlined below, and providing benefits to these populations in terms of air quality, mobility, and access to services and jobs are important goals of this project. According to the Boston Region Metropolitan Planning Organization (MPO), the following transportation-related burdens impact environmental justice populations in the project study area:[7]

- Commuter rail lines pass through the community without providing access to their service;
- The lack of reliable transit services constrains access to job opportunities outside of the immediate neighborhoods;
- The area lacks services such as radial bus connections that access employment centers; and

6 Environmental justice areas are defined by various thresholds for low income populations, minority populations, foreign-born populations, and those lacking in English language proficiency. Therefore, most environmental justice areas contain a mix of environmental justice and non-environmental justice residents.

7 Boston Metropolitan Planning Organization, *Regional Transportation Plan 2004-2025*, 2004.

- Project study area residents lack access to jobs outside of peak-period commuter hours (i.e., peak-periods that demonstrate commuting patterns of "9 to 5" jobs) because there is limited off-peak bus service.

## 3.4 Goals and Objectives

In addition to the Commonwealth's commitments to provide transit service to this area as part of the Central Artery/Tunnel project and the SIP, the Green Line Extension project is also part of MassDOT's efforts to achieve a series of broad transportation goals to improve the quality and equity of transportation services. The goals, associated objectives, and potential evaluation measures are described below.

### 3.4.1 Improve Regional Mobility and Capacity and Expand Transit Access and Intermodal Connections

Mobility improvements in the project study area are expected to result in regional improvements by increasing accessibility for all users, including residents, employees, students, visitors, and shoppers. Residents of the project study area would benefit from improved employment access, as well as reduced travel times and costs. Measures that are used to evaluate the improved transit access and regional mobility include:

- The addition of seat-miles and vehicle-hours of system capacity service;
- Reliability of the service in the project study area;
- User benefits, including travel time savings; and
- Congestion relief.

Increasing mode choice options would improve efficiency and effectiveness of the region's transportation system. Multimodal connections in the project study area between commuter rail, bus services, and rapid transit or light rail would also benefit commuters by improving mobility and flexibility in route choice. Factors to be used in evaluating the effectiveness of increased mode choice options include:

- Mode shift;
- Transit ridership;
- Transit system capacity impacts; and
- Reductions in the number of transfers required.

### 3.4.2 Maximize Transportation Capacity Efficiently

Given the need for increased transit capacity in the project study area and the limited funding resources at all levels, transit improvements should be cost effective and provide a service to the customers that is reliable, comfortable, and attractive, thereby increasing ridership. In order to identify an optimal service, factors to be used in evaluating this goal include:

- Total capital cost;
- Annual operating and maintenance costs; and
- The FTA cost effectiveness index.[8]

### 3.4.3 Improve Air Quality

Transit improvements should contribute to the attainment and long-term maintenance of conformity with National Ambient Air Quality Standards (NAAQS). Factors to be considered in evaluating the air quality benefits of alternatives include:

- Regional ("mesoscale") air quality;
- Energy consumption; and
- Vehicular travel/congestion.

### 3.4.4 Advance Sustainable Development

Proposed transit improvements must advance the Commonwealth's goals for sustainable development. While transportation improvements alone would not necessarily stimulate economic growth, congestion and insufficient access can be major impediments to implementing a smart growth vision. This vision includes walkable, transit-oriented communities, infill development, a regional balance of jobs and housing, and open space preservation. Factors to be considered in evaluating sustainable design benefits of alternatives include:

- Mode shift;
- Transit ridership;
- Congestion relief;
- Support for infill development; and
- Support for walkable communities.

8 United States Department of Transportation, Federal Transit Administration, Office of Planning and Environment, *Fiscal Year 2009 New Starts and Small Starts Evaluation and Rating Process*, July 2007. Available at: http://www.fta.dot.gov/documents/tpeNewStarts_20070720_evaluationAndRating.pdf

### 3.4.5 Provide Services to Environmental Justice Populations

Improvements to transit services would need to be in conformance with environmental justice objectives to provide benefits to these populations in terms of air quality, mobility, and access to services and jobs. Mobility improvements should conform to the Federal, state, and local requirements that are intended to promote nondiscrimination in programs affecting human health and the environment.[9] Factors to be used in evaluating the effectiveness of providing services to environmental justice populations include:

- Service to environmental justice target areas;
- Access to opportunities for residents of environmental justice target areas;
- Improvement in mobility and connectivity and/or removal of barriers faced by environmental justice areas; and
- User benefits, including travel time savings.

9 Clinton, President William J. Executive Order 12898: *Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations*. The White House: Washington, DC, February 11, 1994. Available at: http://www.archives.gov/federal-register/executive-orders/pdf/12898.pdf

# 4

# Alternatives

## 4.1 Introduction

The Alternatives Analysis for this EA included a No-Build Alternative and six "Build" Alternatives. Additionally, a "Baseline" Alternative was evaluated to identify the best option for meeting the transportation needs of the project study area with smaller capital investments than were estimated for the Build Alternatives.[1] Of the six Build Alternatives, four would extend Green Line light rail transit service along branches to both Medford and to Union Square in Somerville; one Build Alternative would provide service along the Medford Branch only (terminating at a new Mystic Valley Parkway/Route 16 Station); and one Build Alternative would provide service along the Union Square Branch only. The Locally Preferred Alternative (LPA) extends the Green Line within existing commuter rail rights-of-way along the Medford Branch terminating at College Avenue in Medford, and along the Union Square Branch, terminating at Prospect Street in Somerville. This alternative is the Proposed Action for this project, and the subject of this EA.

A number of items have been updated over the course of the design phase as the conceptual engineering has advanced and additional analyses have been performed. The changes that affect the information presented in this chapter include:

- **Stations** – Working with the public, local municipalities, and project stakeholders, the proposed station locations and designs were further refined. As described in Section 4.4.4, *Stations*, of this chapter, the refinements to station designs include:
  - Modifying the relocated Lechmere Station layout, busway and roadway, and pedestrian access;

1 United States Department of Transportation, Federal Transit Administration. *New Starts Baseline Alternative Review and Approval Procedures*. Available at: http://www.fta.dot.gov/planning/newstarts/planning_environment_2589.html

- Locating the Washington Street Station (formerly Brickbottom Station) closer to Washington Street for better neighborhood access and to minimizes property acquisitions; and
- Refining the conceptual designs at the stations to provide pickup/drop-off as well as emergency egress at all stations.

- **Maintenance Facility** – Additional site alternatives were further evaluated for the proposed maintenance and storage facility required to support the Green Line Extension. To address and resolve public concerns that were raised following the selection of the Yard 8 site, MassDOT quantitatively analyzed two additional potential sites for the facility – Option L and Mirror H. The Option L site was selected as the preferred location for the maintenance and storage facility in late 2009 and is described in Section 4.4.5, *Maintenance and Storage Facility*, of this chapter.
- **Ridership** – The statewide transportation model, maintained by CTPS was updated with the 2008-2009 systemwide passenger survey results and a revised list of programmed future regional projects.

In addition to these updates, this chapter describes other alternatives considered as part of this project.

Section 4.2, *Ridership Methodology*, discusses the analysis and recent updates that have been made. Section 4.3, *No-Build Alternative*, demonstrates future (2030) conditions with all other committed transportation improvement projects identified in the Massachusetts Transportation Improvement Program (TIP) in place (including both highway and transit projects) but without the Green Line Extension.
Section 4.4, *Proposed Action*, presents the project in detail. Section 4.5, *Alternatives Considered but Dismissed*, describes the Baseline Alternative and the Build Alternatives considered, evaluated in the DEIR/EA, and dismissed from further consideration. The Baseline Alternative employs a transportation systems management (TSM) approach to identify the best option for meeting the transportation needs of the project study area without implementing a fixed-guideway transit service. Section 4.5, *Alternatives Considered but Dismissed,* also includes a discussion of additional station locations and vehicle maintenance and storage facility locations considered and dismissed from further consideration. Section 4.6, *New Starts Criteria and Status Update*, discusses the current application status, and Section 4.7, *Summary,* of this chapter provides a summary of the Alternatives Analysis.

## 4.2 Ridership Methodology

Ridership for the Baseline and Build Alternatives was forecast by CTPS using the regional model and land use assumptions in compliance with the FTA's requirements and consistent with the project study area. The model calculated ridership projections for a forecast year of 2030 and assumes that a number of proposed transportation projects consistent with the Regional Transportation Plan (RTP) would be implemented by this time. A detailed summary of the travel demand modeling methodology and assumptions utilized by CTPS is included in Appendix B, *Travel Demand Modeling Methodology*.

A detailed operating plan for the Proposed Action was developed, including identifying the number and types of vehicles, size, vehicle capacity, travel times, and peak and off-peak headways. The operating plan was developed as an extension of existing Green Line D and E branch services, to minimize any impact to the Central Subway system operations. Existing service frequencies and headways were maintained for the branch lines within the Central Subway and these lines were extended beyond Lechmere Station with the same service plans. A detailed description of the operating plan for the Proposed Action is included in Section 4.4, *Proposed Action*. Detailed descriptions of the operating plans for each of the dismissed Build Alternatives are included in Section 4.5, *Alternatives Considered but Dismissed*.

Future ridership projections were calculated on a system-wide level and for each proposed station location by identifying new transit trips generated and boardings at each station. The reduction in the VMT generated by each Build Alternative was calculated. VMT reduction estimates were calculated based on both new and diverted trips. Ridership projections are described in Section 4.4, *Proposed Action*, and Section 4.5, *Alternatives Considered but Dismissed*.

The additional ridership projected for the Green Line Extension was evaluated by CTPS for its impact on existing Green Line capacity on the various segments of the system, including the Central Subway. The summary of this analysis, included in Appendix B, *Travel Demand Modeling Methodology*, indicates that all of the segments of the Green Line branches are capable of accommodating the projected peak transit loads in both the AM and PM hours. Based on CTPS' analysis, none of the peak load segments exceed the MBTA's maximum load service policy.

The regional transportation model has been updated to include the 2009 RTP (including slightly updated land use), the addition of station choice (pickup/drop-off), a revised list of regional background projects that are expected to be constructed by 2030, updated on-board passenger surveys, and other network enhancements. Ridership has been updated for the No-Build Alternative, the Baseline Alternative, and the Proposed Action only. The ridership of the other Build Alternatives that were evaluated in the DEIR/EA and eventually dismissed has not been updated.

## 4.3 No-Build Alternative

The No-Build Alternative consists of the existing transportation facilities and services and all future committed transportation improvement projects without the extension of the Green Line. The No-Build Alternative includes anticipated changes to the transportation infrastructure including highway and transit projects currently shown in the TIP long-range regional plans, and proposed improvements along Monsignor O'Brien Highway/Route 28 associated with the NorthPoint development. It represents the condition against which the transportation benefits and environmental impacts of the Baseline and Build Alternatives were measured. The committed improvements included as part of the No-Build Alternative are summarized in Section 6.5.2, *Environmental Consequences*. The No-Build Alternative does not meet the project purpose because it would not improve corridor mobility, boost transit ridership, improve regional air quality, ensure equitable distribution of transit services, or support opportunities for smart growth initiatives and sustainable development.

## 4.4 Proposed Action

The Proposed Action would provide transit service to College Avenue in Medford and Union Square in Somerville using a two-branch operation, both in existing commuter rail rights-of-way. The 3.4-mile Medford Branch would operate from a relocated Lechmere Station to College Avenue in Medford within the MBTA Lowell Line commuter rail right-of-way. This branch would begin at relocated Lechmere Station and head northwest, meeting the MBTA Lowell Line just south of Washington Street in Somerville. From Washington Street, the alignment would run parallel to the MBTA Lowell Line to Medford, terminating at College Avenue in Medford. The 0.9-mile Union Square Branch would operate within the MBTA Fitchburg Line commuter rail right-of-way from relocated Lechmere Station to a terminus at Union Square in Somerville. Figure 1.1-2 shows the conceptual alignment of the Proposed Action, including both the Medford Branch and the Union Square Branch.

The Proposed Action is expected to generate anticipated daily ridership (boardings and alightings) at the project's seven stations of approximately 49,000 by the year 2030, with approximately 92 percent of these trips beginning in the project's opening year of 2019. The Green Line would also see an increase of 25,970 boardings and the entire MBTA system would see an increase of 7,500 new daily linked transit trips as a result of the extension of the Green Line service. The Proposed Action would reduce VMTs by 25,728 per day (projected to the year 2030).

## 4.4.1 Travel Times

Travel times between proposed stations were estimated based on travel distances and estimated speeds. The travel speeds between proposed stations were based on the railroad's physical and operational characteristics. Estimated travel time between each station for the proposed Green Line Medford Branch is shown in Table 4.4-1.

**Table 4.4-1 Proposed Action: Medford Branch Travel Times**

| Station | Travel Time (minutes) | Dwell Time (minutes) | Cumulative Travel Time (minutes) |
|---|---|---|---|
| Lechmere | | | |
| Washington Street | 2.25 | 0.75 | 3 |
| Gilman Square | 1.25 | 0.75 | 2 |
| Lowell Street | 1.25 | 0.75 | 2 |
| Ball Square | 0.75 | 0.75 | 1.5 |
| College Avenue | 1.0 | 0 | 1.0 |
| | | Total | 9.5 |

Estimated travel time between College Avenue Station and Lechmere Station for the proposed Green Line Medford Branch is 9.5 minutes. Estimated travel time between Union Square and the relocated Lechmere Station for the proposed Green Line Union Square Branch is 4.5 minutes.

## 4.4.2 Headways

Green Line service beyond relocated Lechmere Station for the Medford Branch would operate on headways equal to that of the existing Green Line D branch service: five minutes in the morning and evening peak periods and 10 minutes during off-peak periods.

Green Line service beyond relocated Lechmere Station for the Union Square Branch would operate on headways equal to that of the existing Green Line E branch service: six minutes in the morning peak period, five minutes in the evening peak period, and between nine and 10 minutes during off-peak periods.

## 4.4.3 Fares

Fares for the Green Line Medford Branch and Union Square Branch would be $1.70 for one-way adult trips using a Charlie Card, based on current MBTA subway fares.

### 4.4.4 Stations

Seven stations would be constructed for the Proposed Action:

- Relocated Lechmere Station, Cambridge;
- Washington Street Station, Somerville;
- Gilman Square Station, Somerville;
- Lowell Street Station, Somerville;
- Ball Square Station, Somerville/Medford line;
- College Avenue Station, Medford; and
- Union Square Station, Somerville.

Figures 4.4-1 and 4.4-2 show the station locations along the Green Line Extension project corridor. Project stations would be located along the new Green Line alignment adjacent to the relocated MBTA Lowell Line for the Medford Branch, and along the MBTA Fitchburg Line for Union Square Branch. Station locations for the Green Line Extension project were identified through a station siting analysis process, which included input from the public and state and local officials.

Various design criteria were developed to evaluate the benefits and disadvantages of possible station locations. These evaluation criteria included, but were not limited to, station access, transit operations, land use compatibility, and costs. Each station alternative was rated numerically using a range, from negative two for the most unfavorable to positive two for the most favorable, based on each design criterion. All ratings were summed for each alternative location, and the final station site was selected based on the option that received the highest score for each Build Alternative (Appendix H, *Station and Alignment Selection Analysis*).

Station locations and design were also based on feedback received from the public at Station Workshops and from public officials concerning accessibility, LOS, passenger circulation, and safety requirements. Keeping uniform architectural elements was also an important station design goal. The following codes and standards were used for consistency with local and state requirements, as well as MBTA and other transit standards and guidelines:

- Massachusetts State Building Code 780 CMR, Sixth Edition;
- Massachusetts State Elevator Code 524 CMR, 2003;
- National Fire Protection Association (NFPA) 101 Life Safety Code, 1994 (Per 6th edition of CMR 780);
- NFPA 130 Standard for Fixed Guideway Transit Systems, 1995 (Per 6th edition of CMR 780);
- Massachusetts AAB 521 CMR, 2002;

- American Society of Mechanical Engineers (ASME) A17.1 Safety Code for Elevators and Escalators, 2000;
- MBTA Guidelines & Standards, 1977;
- MBTA Guide to Access, 1990;
- American Public Transportation Association (APTA) Guidelines, 1981;
- ADA Accessibility Guidelines for Buildings and Facilities (in connection with Uniform Federal Accessibility Standards), 2002;
- Transit Capacity and Quality of Service Manual (2nd edition), Transit Cooperative Research Program (TCRP) Report 100, 2003;
- Pedestrian Planning and Design,[2] Dr. John Fruin, Second Edition 1987; and
- Boston Center for Independent Living (BCIL) agreement.

Each station, as shown in the conceptual designs and cross-sections (Figures 4.4-3 through 4.4-16), would provide a headhouse as a shelter for the paid and unpaid lobbies with automated fare lines, vending machines, an information booth, and restrooms. All new stations would be constructed to meet the ADA standards for providing fully accessible stations. The stations also include:

- Landscaping;
- Bike racks, which would encourage the use of bicycles to access the station and reduce vehicular access;
- MBTA Direction Maps showing inbound and outbound stations as well as the MBTA Spider Maps showing all rapid transit lines;
- Street-facing fascia displaying the station name;
- Covered, uniformly lit platforms at a level that enhances a feeling of safety;
- Tactile/Braille Station Identification signs; and
- Trash and recycling receptacles.

Stations are intended to function as neighborhood stations with no provisions for parking, with the exception of the relocated Lechmere Station. Stations were designed to meet the project's goals of improved transit access and accessibility, and to minimize impacts to the community associated with land acquisition, traffic, and loss of local parking.

Most station platforms are envisioned to be at a different elevation than the station access points. Entry to and exit from the platforms would be by elevators, escalators,

2 Fruin, J. *Pedestrian Planning and Design*. 2nd Edition, Elevator World, Mobile Alabama. 1987.

and stairs. Platform designs were based on peak hour passenger volumes. Station access and platform design were based on requirements and guidance provided by the ADA, the AAB, and requirements of the MBTA.

In addition to station amenities and access requirements, station criteria also considered environmentally responsible design, including:

- **Access –** Stations would offer safe and convenient pedestrian access to encourage walking and transit-oriented development in the vicinity. This includes providing secure bicycle racks and/or storage within 200 yards of each station entrance.
- **Lighting –** Station design would minimize light pollution on each station site, while ensuring that adequate safety lighting measures are adhered to.
- **Stormwater –** Station design would minimize the amount of impervious cover, increase on-site stormwater infiltration, and reduce or eliminate pollution from stormwater runoff.
- **Recycling –** Stations would provide easily accessible bins for recycling, including paper, corrugated cardboard, glass, plastics, and metals.
- **Site and Building Materials –** Where possible, stations would use materials that incorporate recycled content materials; are extracted and manufactured locally; reduce the use and depletion of finite raw materials and long-cycle renewable materials by replacing them with rapidly renewable materials, such as bamboo, wool, cotton insulation, agrifiber, linoleum, wheat-board, strawboard, and cork; use Forest Stewardship Council (FSC) Certified Wood; and reduce the heat island effect at each station by utilizing high-reflectance (high-albedo) materials for hardscape.
- **Water Efficiency –** Where possible, station design would eliminate the use of potable water for landscape irrigation at each station site and would reduce the generation of wastewater and potable water demand at each station by specifying high-efficiency fixtures and dry fixtures, such as waterless urinals and low-flow toilets.
- **Energy Performance –** Where possible, station design would configure the building envelope, heating, ventilation, and air conditioning (HVAC), lighting, and other systems to maximize energy performance; use non-polluting and renewable energy sources, including solar, wind, geothermal, low-impact hydro, biomass, and bio-gas strategies; avoid or minimize the use of mechanical cooling and refrigeration equipment; and use ENERGY STAR compliant products throughout all buildings.
- **Indoor Air Quality –** Where possible, station design would include an indoor air quality management plan to address moisture and mold damage including the design of surface grades, drainage systems and heating, ventilating, and air conditioning systems, ductwork transport, storage, and installation and filtration

media in air handlers. Effective air management systems would be employed to minimize the exposure of station occupants and ventilation air distribution systems to environmental tobacco smoke; provide additional outdoor ventilation to improve air quality within the station building; provide capacity for ventilation system monitoring to help sustain station occupant comfort; and reduce the quantity of indoor air contaminants that are odorous, irritating, or harmful to station occupants.

- **Demolition and Construction –** Where possible, construction management during demolition of existing buildings on the station sites would divert debris from disposal in landfills and incinerators. Station design would include Erosion and Sediment Control Plans and would consider additional methods to control polluting the air with dust and particulate matter during construction.

Brief descriptions of each proposed station are provided below. The station descriptions follow the geographical sequence of the stations in the outbound direction, from Lechmere Station to Union Station. The latest NFPA regulations require an emergency egress for each station to provide a safe exit from the platform away from the station structure to a public way. An emergency egress is proposed for each station to meet these criteria. First the Medford Branch stations are described, then the Union Square Station.

## Relocated Lechmere Station

Lechmere Station, located in east Cambridge, is currently the terminus of the Green Line on the northern end of the MBTA's system. The Green Line Extension project would extend transit service from its current terminal at Lechmere Station to Medford along the MBTA Lowell Line, with a branch line from relocated Lechmere Station to Union Square via the MBTA Fitchburg Line. In order to minimize the impacts from the extension and utilize existing MBTA right-of-way, Lechmere Station would be relocated. A new elevated Lechmere Station would be constructed on the east side of Monsignor O'Brien Highway/Route 28 with a new and realigned viaduct. Figures 4.4-3 and 4.4-4 depict the relocated Lechmere Station layout, cross section, and the surrounding neighborhood. Daily ridership at this station is anticipated to be approximately 8,820 boardings (projected to the year 2030).

The need to relocate the station, alternatives evaluated, and the environmental consequences of moving the station were evaluated. Station refinements modified the station design, access plan, urban design considerations, anticipated environmental impacts, and proposed mitigation measures.

Throughout the concept planning for this station, and continuing through the design, MassDOT and the MBTA have worked with the City of Cambridge and local stakeholders to design and implement a traffic plan that works to support the station and also works in conjunction with the NorthPoint development project, which has been partially built to date and will continue its build out over the next several years. All traffic improvements proposed by MassDOT and the MBTA for the Green Line Extension project have been proposed to mitigate the impacts of the Lechmere Station relocation, support the MBTA's bus operations, and/or to improve access to the station for its customers. The improvements to be implemented by the project are all necessary for customers to safely access the new station.

Modifications made to the relocated Lechmere Station layout include:

- The proposed parking program would include 180 parking spaces. These parking spaces would be provided in two separate parking lots and would replace some of the 347 parking spaces that exist today at Lechmere Station.
- Roadway improvements along Monsignor O'Brien Highway/Route 28 are included in the revised station layout. Several of these modifications are further discussed in Section 6.5, *Traffic and Transportation Systems*, of this EA:
- An exclusive busway with one-way circulation to accommodate local bus service, including MBTA Bus Routes 69, 80, 87, and 88, with access and egress from Monsignor O'Brien Highway/Route 28 via Water Street.
- The bus layover would be located farther away from the Glass Factory Condominiums.
- An access road would be provided to connect Water Street, North First Street, and East Street allowing vehicular access through the station limits.
- Vehicular access to the north parking lot would be provided via Water Street and the one-way southbound segment of the station access road.
- Vehicular access would be provided to the south parking lot via East Street with connections from Water Street and North First Street.
- Curbside drop-offs for taxis, corporate shuttles, and station patrons would be provided at the station along the access road and also along new North First Street.
- Pedestrian access would be provided by a wider (15 feet wide) crosswalk across Monsignor O'Brien Highway/Route 28. All new crosswalks along Monsignor O'Brien Highway/Route 28 and at Cambridge Street and First Street would be designed in compliance with the FHWA's Manual on Uniform Traffic Control Devices (MUTCD), ADA standards and associated state requirements.
- In earlier stages of public outreach, many comments were raised by the public that related to the design of the station and suggestions as to how to improve access to the station and/or reduce impacts of the station on the surrounding neighborhood. In response to those comments, the following design elements at the station have been modified:

- Access into the station headhouse would be added from both the north and south sides of the building structure. This would allow direct access to the station from the bus pickup/drop-off area on the north and from the intersection of Monsignor O'Brien Highway/Route 28 and North First Street on the south.
- The automatic fare collection and other station amenities would be fully enclosed within the station headhouse and protected from the elements.
- A canopy system would start along the perimeter of the headhouse, underneath the elevated structure, and extend to the northeast corner of the intersection of Monsignor O'Brien Highway/Route 28 and North First Street. The canopy system would establish an architectural presence on Monsignor O'Brien Highway/Route 28, which would increase station visibility. This architectural feature would better define the station entry and directs users to the station area.
- Because the station would no longer function as a terminal station, the proposed center island platform length was reduced from 450 feet long to 225 feet long, which can adequately accommodate a typical three-car Green Line trainset (rather than two trainsets, as required in the terminal station layout). The platforms would continue to be accessed using elevators, escalators, and stairs.
- Bicycle racks would be provided to encourage use of this mode.
- The emergency egress for the Lechmere Station is essentially part of the track and platform viaduct structure. The egress is a stairway and elevator shaft proposed from the south end of the platform down to the at-grade parking lot below. A one-way gate is proposed at the parking lot level to provide access to the parking lot, which abuts East Street and Monsignor O'Brien Highway. A separate egress easement is not required.

In the next stages of the project, the visual identity of the station would be further explored and final design would be advanced. The station identity would be shaped by the design of platform and station elements (canopy, elevators, side walls, etc.). Visual qualities that integrate station elements and Green Line infrastructure would be investigated. Design elements would have to be balanced with potential neighborhood impacts (such as those associated with extensive glass surfaces, including noise and light impacts). Additional aspects of the station that influence its appearance and would be evaluated in more detail are providing security, visibility, and noise mitigation.

Because Lechmere Station is being constructed on property already owned by the MBTA, it is anticipated that no additional private property acquisitions would be required to construct the station.

## Washington Street Station

The proposed Washington Street Station (formerly Brickbottom Station) would be located just south of Washington Street. The station entrance would be located directly under the Washington Street bridge structure to the south. MassDOT has worked extensively with the City of Somerville and other stakeholders to modify the layout of the station in such a way that locates the station closer to Washington Street and avoids the need for any property acquisitions to construct the station. At this location, the Green Line tracks would be at a higher elevation than Washington Street. Consequently, access to the platform would occur from below via elevators, escalators, and stairs. Figures 4.4-5 and 4.4-6 show the revised station layout, cross section and the surrounding neighborhood. Daily ridership at this station is anticipated to be 2,830 boardings (projected to the year 2030).

Access to the station would be provided for vehicular traffic on the MBTA's property east of the station, where spaces for pickup/drop-off for automobiles would be provided. The location would also facilitate transfers between the station and three MBTA bus routes that operate on Washington Street a short distance away. The station is also immediately adjacent to the proposed Somerville Community Path, at the path's transition from the MBTA Lowell Line right-of-way to the Inner Belt Area. Bike racks would be provided to encourage use of this mode.

An emergency egress is proposed from the south end of the platform between the Green Line tracks, which extends in a southerly direction for approximately 200 feet. The egress crosses the Green Line outbound track at-grade and extends to the parking lot of 200 Inner Belt Road where an access easement would be needed through the parking lot to provide a connection to Inner Belt Road. A one-way gate is proposed through the proposed fence at the edge of the parking lot for 200 Inner Belt Road.

No property acquisitions would be required to construct this station.

## Gilman Square Station

Gilman Square Station is proposed to be located along Medford Street directly behind Somerville High School. The station headhouse would be located near the intersection of Medford Street and Pearl Street, on the far side of the tracks from the Somerville City Center (which includes Somerville City Hall, the Somerville Public Library, and Somerville High School). Figures 4.4-7 and 4.4-8 show the revised station layout, cross section and the surrounding neighborhood. Daily ridership at this station is anticipated to be 3,930 boardings (projected to the year 2030).

The station headhouse would provide access from two points: the Medford Street bridge, and a City-owned parcel along the northeast side of the tracks. A vehicle drop-off area would be provided on the City parcel. Access from the headhouse to the platform level would be via a footbridge across the commuter rail tracks, elevators, escalators, and stairs. Because Medford Street is steeply sloped on the north side of the tracks, the headhouse provides upper and lower level entrances to enable barrier-free station access.

Access from the City Center and Highland Avenue would be provided via the Medford Street bridge. In the future, connections to the proposed Somerville Community Path are possible via Medford Street and a possible bridge connecting the headhouse with the proposed Somerville Community Path. MBTA Bus Route 80 currently provides stops near the proposed station headhouse. MBTA Bus Routes 88 and 90 are located within a quarter of a mile of the station. Bike racks would be provided near the headhouse. Vehicular pickup/drop-off would be provided at the station.

An emergency egress is proposed from the north end of the platform between the Green Line tracks, which leads to a fully accessible ramp system that provides access from platform level to School Street above the railroad right-of-way. A one-way gate is proposed on the School Street Bridge to provide egress onto the bridge from the ramp.

The proposed Gilman Square Station footprint and access path extend outside of current MBTA property. Private property acquisitions would be required for the Gilman Square Station.

## Lowell Street Station

Lowell Street Station is proposed to be located at Lowell Street, adjacent to a brownfield site where multi-family housing is currently under construction (MaxPac Square). Figures 4.4-9 and 4.4-10 show the revised station layout, cross section and the surrounding neighborhood. Daily ridership at this station is anticipated to be 1,140 boardings (projected to the year 2030).

Lowell Street would be reconstructed near the station to provide sufficient clearance beneath the bridge, a vehicle drop-off, and improved pedestrian and bicycle access. The Green Line tracks and platform would be at a lower elevation than Lowell Street. Consequently, access to the platform would occur from street level via elevators, escalators, and stairs. Bike racks would be provided. MBTA Bus Routes 80, 88, and 90 stop within one third of a mile of the station. Connections from the proposed Somerville Community Path to the station headhouse would be possible via Lowell Street.

An emergency egress is proposed from the north end of the platform between the Green Line tracks. The egress crosses the Green Line inbound track at-grade and extends to a five-foot high ramp that leads to a one-way gate on the retaining wall to be constructed by KSS Realty Partners, Inc. as part of the MaxPac Square residential development. KSS Realty Partners, Inc has granted an easement to the MBTA along a sidewalk to be constructed by KSS Realty Partners, Inc that would lead to

Clyde Street. The sidewalk portion of the egress within the MaxPac Square site would be maintained by the manager of the residential development.

Because Lowell Street Station is being constructed on property already owned by the MBTA, it is anticipated that no additional private property acquisitions would be required to construct the station.

## Ball Square Station

Ball Square Station is proposed to be located on the north side of the Broadway Bridge in the vicinity of the Somerville and Medford city line, near the corner of Broadway and Boston Avenue. Figures 4.4-11 and 4.4-12 show the revised station layout, cross section and the surrounding neighborhood. Daily ridership at this station is anticipated to be 1,850 boardings (projected to the year 2030).

At this station, the Green Line tracks and platform would be at a lower elevation than Broadway; consequently, access to the platform from street level would be via elevators, escalators, and stairs. Due to Broadway's steep grade, the station provides headhouse entrances on two levels. The upper level would be entered from a new pocket pedestrian plaza on Broadway above the tracks. The other access point would be from a track-level parcel acquired for station and track construction, near the intersection of Boston Avenue and Broadway. Bike racks would be provided at the station. A vehicular pickup/drop-off area would also be provided at the station, which can be accessed from Boston Avenue. MBTA Bus Routes 80 and 89 travel on Broadway at the immediate station site.

An emergency egress is proposed from the north end of the platform between the Green Line tracks. The egress crosses the Green Line inbound track at-grade and extends to a one-way gate through the fence along the proposed station access road. From that point the access road can be used to get to Boston Avenue. The access road is proposed on MBTA property and therefore a separate access easement is not required.

The proposed Ball Square Station footprint extends outside of current MBTA property. Private property acquisitions would be required for the Ball Square Station.

## College Avenue Station

College Avenue Station is proposed to be located at the corner of College Avenue and Boston Avenue. The station would be located across Boston Avenue from the main Tufts University campus and is surrounded by Tufts facilities. Residential areas in Medford and Somerville and a commercial district on Boston Avenue are within walking distance of the station. Figures 4.4-13 and 4.4-14 show the revised station layout, cross section and the surrounding neighborhood. In the Proposed Action, College Avenue Station would serve as the terminal station for the Medford Branch. Tail tracks would be provided beyond the end of the platform for operational flexibility at the end of the line. Daily ridership at College Avenue Station is anticipated to be 2,140 boardings (projected to the year 2030).

In order to meet accessibility requirements, and taking into consideration the eight percent grade along the College Avenue bridge, the station provides a headhouse with two points of access at the same level. The north side of the headhouse would open to a new pedestrian plaza above the tracks. This plaza would connect to College Avenue at the northeastern end of the College Avenue bridge, though the plaza elevation would generally be higher than the roadway and sidewalk on the bridge. The second access point would be provided from the southwest side along Boston Avenue. The wide sidewalk would be maintained along the College Avenue bridge for regular pedestrian access. Detailed station designs would be advanced during the next stage of project development.

The traffic analysis indicated that a right turn lane from southbound College Avenue to westbound Boston Avenue is needed. The existing bridge over the commuter rail tracks would need to be widened to accommodate the right turn lane. Two paralleling Massachusetts Water Resources Authority (MWRA) water lines (48-inch and 20-inch) would need to be relocated to accommodate the bridge widening. An alternative to the bridge widening is being considered to reduce bridge widening and water main relocation issues. The alternative under consideration would add a separate single-lane bridge, adjacent to the existing bridge and water lines. The existing bridge would not need to be widened nor would the water lines need to be relocated.

Vehicular pickup/drop-off is currently planned along the northbound side of Boston Avenue, in the area where parking does not currently exist. Bicycle parking would be provided near the head house. MBTA Bus Routes 80, 94, and 96 pass from College Avenue to Boston Avenue near the station site. Tufts University campus shuttles also operate near the proposed station and would potentially connect to the station. Figure 4.4-13 indicates the current locations for bus stops near the station.

An emergency egress is proposed from the north end of the platform between the Green Line tracks. From the end of the platform a ramp system can be used to get up to a proposed bridge structure that spans over the proposed Green Line Inbound track and leads to a one-way gate at the back of the Boston Avenue sidewalk. The Boston Avenue right-of-way abuts the railroad right-of-way in this area and therefore a separate access easement is not required.

The proposed College Avenue Station footprint and access path extend outside of current MBTA property. Private property acquisitions would be required for the College Avenue Station. Additional private property acquisition may be required for the right turn lane bridge if this alternative is selected.

### Union Square Station

Union Square Station is the only proposed station on the Union Square Branch. It would be located at the intersection of the MBTA Fitchburg Line right-of-way and Prospect Street. Somerville's Union Square mixed-use neighborhood hub is within one fifth of a mile of the station. Cambridge's Inman Square commercial district is one third of a mile south of the station. Figures 4.4-15 and 4.4-16 show the revised station layout, cross section, and the surrounding neighborhood. Daily ridership at this station is anticipated to be 3,570 boardings (projected to the year 2030).

Due to the eight percent grade along Prospect Street, the station is envisioned to provide access at two levels, including the lower grades along Prospect Street as well as directly from the bridge structure. Access to the platform would occur via elevators, escalators, and stairs. Vehicular pickup/drop-off would be accommodated by a new vehicular access way via Prospect Street. Bike parking would be provided at the station. Five MBTA bus routes travel near the station.

An emergency egress is proposed from the east end of the platform between the Green Line tracks, which extends in an easterly direction for approximately 100 feet. The egress crosses the Green Line outbound track at-grade and extends to a one-way gate at the corner of Allen Street. An access easement is required across the 51 Allen Street property, which is currently vacant.

The proposed Union Square Station footprint extends outside of current MBTA property. Private property acquisitions would be required for the Union Square Station.

## 4.4.5 Maintenance and Storage Facility

The proposed Green Line Extension project maintenance and storage facility would be immediately adjacent to and northwest of the existing MBTA Boston Engine Terminal commuter rail maintenance facility. The site is situated along the southern and southeastern fringe of the existing Inner Belt industrial area of Somerville. It is adjacent to the "Valley Tracks," a railroad connection between the MBTA Fitchburg, Haverhill, Newburyport, and Rockport commuter rail lines. The proposed facility includes storage for approximately 80 Green Line vehicles, three pit tracks, two lift tracks, one wheel truer track, support shops, Green Line vehicle wash, administrative office space, and approximately 150 to 170 parking spaces for employee and MBTA vehicles in a parking deck and surface lot. The facility is designed to accommodate potential future air rights development. The facility layout is shown in Figure 4.4-17.

Developing the maintenance and storage facility at this site would require the complete acquisition of two parcels and partial acquisition of two other parcels. The land required for the maintenance and storage facility includes the building and parking lot at 44-48 Third Avenue; the building and parking lot at 20 Third Avenue; the isolated parking lot at 70 Inner Belt Road; plus the undeveloped, southern corner of 200 Inner Belt Road. The building located at 44-48 Third Avenue (formerly occupied by Digital Publishing Solutions, Inc.) is being leased temporarily as an indoor parking/storage facility for federally confiscated vehicles.

The layout of the proposed facility includes two storage yards (the “south” and “east” yards), the maintenance building, and a transportation building. The south yard would be located immediately south of the hook in Inner Belt Road, just north of the MBTA Fitchburg Line while the east yard would be located to the east of the maintenance building and south of Third Avenue. To provide double-ended access to the building, a loop track would circle east of the building and around the east storage yard.

### 4.4.6 Vehicle Requirements

The Green Line Extension project vehicle fleet would include a mix of three vehicle types: the two current vehicles (Type 7 high-floor cars and Type 8 low-floor cars) and a new Type 9 low-floor car, which is currently under development. All three vehicle types would be able to operate within the existing system and along the Green Line Extension.

In general, the current Green Line trainsets (or “consists”) include two or three cars. For the purpose of calculating the number of required cars, two-car Green Line trains were conservatively assumed. Based on the MBTA’s 2010 Service Delivery Policy,[3] the seating capacity of each Green Line car is 44 to 46 seats, depending on the car type, and the maximum peak load standard is 225 percent of the seated capacity for the peak periods. This translates into a peak period train capacity of 198 to 207 passengers per trainset. In order to accommodate the projected ridership and proposed operating plan for the extension, it was calculated that 24 additional Green Line cars would be needed for the Green Line Extension project. The proposed track and stations have been designed so as not to preclude future platform expansion to accommodate up to four-car trainsets.

### 4.4.7 Capital Improvements

The primary infrastructure improvements of the Proposed Action would include relocating existing commuter rail lines; constructing approximately four miles of new light rail track and systems, four multi-span viaducts, a vehicle maintenance and storage facility; and reconstructing 11 bridge structures to support the extended service.

3 Massachusetts Bay Transportation Authority. *Service Delivery Policy*, June 2, 2010. Available at: http://www.mbta.com/uploadedfiles/About_the_T/T_Projects/T_Projects_List/2010ServiceDeliveryPolicy.pdf

Capital improvements for the Medford Branch include construction of light rail tracks and OCS along the existing rail right-of-way between the relocated Lechmere Station and College Avenue in Medford. Improvements also include use of the MBTA's portion of the "Yard 8" right-of-way between relocated Lechmere Station and Washington Street and along the MBTA Lowell Line between Washington Street and College Avenue. The Green Line service would end immediately north of the College Avenue overpass. A support facility for storing and servicing the Green Line fleet would be constructed to accommodate the existing north-side Green Line service fleet and the additional fleet of 24 vehicles. In addition to the track construction, some of the existing bridges along the right-of-way would need to be reconstructed to accommodate the additional tracks. Existing track and signal equipment would also need to be relocated in order to accommodate the planned light rail tracks. Since College Avenue would be the terminus for the line, additional track lengths would be required north of the station for short-term storage and operational flexibility.

The Union Square Branch would also require light rail tracks and OCS to be constructed along the MBTA Fitchburg Line between the former Red Bridge and the proposed Union Square Station near Prospect Street. The alignment to Union Square would require reconfiguration of the existing signal equipment as well as the commuter rail and freight rail tracks between the MBTA Boston Engine Terminal facility and Webster Avenue. The existing rail bridge over Medford Street along the right-of-way would need to be reconstructed to accommodate the additional tracks.

The Proposed Action would reconstruct seven roadway bridges over the proposed alignment, three railroad bridges above streets on the Medford Branch, and one Mainline light rail bridge over the MBTA Fitchburg Line. Additionally, three light rail viaducts would be constructed. The following road, railroad, or light rail bridges would have to be either replaced or added as part of the Proposed Action:

- Cambridge:
  - Lechmere viaduct (steel portion only) over East and Water Streets (new light rail structure)
- Somerville:
  - Union Square Branch viaducts (two new) (over the MBTA Fitchburg Line)
  - Former Red Bridge Railroad Bridge (new light rail only crossing the MBTA Fitchburg Line)
  - Washington Street Railroad Bridge
  - Walnut Street
  - Medford Street Roadway Bridge (MBTA Lowell Line)
  - Medford Street Railroad Bridge (MBTA Fitchburg Line)
  - School Street
  - Lowell Street

   - Cedar Street
   - Broadway

- Medford:

   - Harvard Street Railroad Bridge
   - College Avenue

The following bridges in Somerville appear to have adequate clearance and should not need replacement:

- Central Street
- Sycamore Street
- Prospect Street
- McGrath Highway (MBTA Lowell Line)
- Cross Street
- McGrath Highway (MBTA Fitchburg Line)

Of the railroad bridges, the bridge over Washington Street can accommodate six tracks but must be replaced due to its poor condition. The bridge that carries the MBTA Lowell Line over Harvard Street would have to be reconstructed to add two spans to accommodate four tracks. The bridge that carries the MBTA Fitchburg Line over Medford Street would have to be reconstructed to add two spans to accommodate four tracks. The former rail bridge over the MBTA Fitchburg Line at Red Bridge Junction would have to be reconstructed as a light rail only span, and two new viaducts would be needed at Red Bridge Junction to serve the Union Square Branch. The Lechmere Viaduct (steel portion only) over Monsignor O'Brien Highway/Route 28 in Cambridge would be replaced by a new light rail viaduct paralleling the highway on its north side and incorporating the relocated Lechmere Station. The design and construction of these bridges would be coordinated with appropriate municipal personnel in Cambridge, Somerville, and Medford.

New signal, communications, and electrical systems would be required for the Green Line Extension project. The Proposed Action would require Automatic Wayside Block Signals to govern Green Line train operations for both the Medford Branch and the Union Square Branch.

Multiple communication systems are proposed for MBTA operations, MBTA staff communications, mechanical system monitoring, passenger communications, and emergency reporting. These include the following systems:

- Automatic Vehicle Identification (AVI) to provide real time train locations and destinations;

- Wayside Telephone System for MBTA staff communications with the Operations Control Center (OCC);
- Automatic Station Identification (ASI) to passengers with up-to-date information on train status;
- Wide Area Network (WAN) to interconnect computers at MBTA stations and facilities with the OCC;
- Public Address System that transmits audible messages that correspond with light-emitting diode (LED) messages;
- LED Signage System that provides LED visual text messages synchronized with the Public Address System per ADA requirements;
- Closed Circuit Television (CCTV) that provides real time analog and IP video from cameras at each station and facility;
- Supervisory Control and Data Acquisition (SCADA) Systems to monitor fire alarm, escalators and elevators at each station;
- Customer Information Call Boxes at each station to provide a direct line to the MBTA Police and the Maintenance Terminal; and
- Fire Alarm Systems at each station and at the maintenance facility.

Traction power for the Green Line is provided by 600-volt DC through an OCS. The Proposed Action would require traction power substations power both the Medford Branch and the Union Square Branch. New substations would be required at the proposed maintenance and storage facility and at Ball Square Station. An existing inactive substation at School Street in Somerville would be reactivated. The traction power feeders and returns would be installed in underground electrical conduits. The OCS would consist of an overhead auto-tension catenary system registered and supported on cantilever-type assemblies, span wire assemblies, and portal bents.[4]

### 4.4.8 Conceptual Costs

Conceptual design plans for the Proposed Action and capital cost estimates were developed. The capital improvements include, but are not limited to, construction of track, stations, structures, systems, drainage, utilities, and the maintenance facility. Additional costs include property acquisitions and relocations, vehicle acquisition, and the cost to reconstruct Lechmere Station. The overall cost of the Proposed Action is currently estimated to be approximately $971 million in 2011 dollars, including $82 million for the 24 Green Line vehicles, plus finance charges. Annual operating and maintenance costs would be approximately $24.5 million in 2011 dollars.

4 Portal bent – A type of catenary support with a column on both sides of the tracks and a crossbeam on top.

The total costs for the Proposed Action were refined to include inflation for the time period in which the project is to be implemented. The YOE capital costs for the Proposed Action were calculated to be approximately $1.1 billion in YOE dollars, plus finance charges.

### 4.4.9 Land Acquisitions and Easements

The Green Line Extension project makes use of existing railroad rights-of-way for most of its length. This is possible because, dating back to the late nineteenth century, the MBTA Fitchburg Line and the MBTA Lowell Line had sufficient width (55 to 110 feet) to accommodate additional tracks for freight rail lines that have since been abandoned. The footprint of the abandoned tracks provides space for new tracks for the Proposed Action to be accommodated within the existing right-of-way (Figure 4.4-19). In places where space is limited by steep slopes, retaining walls are proposed to maximize usable space in the rail rights-of-way. The proposed retaining walls would incorporate “green” design components by using recycled and recyclable materials and vegetation as part of the wall system. These green-design components would provide a more natural appearance for the retaining structure. Landscape treatments would also be proposed on the slopes above the walls and to the greatest extent possible at each of the stations.

Conceptual design plans were prepared and used to identify the maximum property impacts of the project (Figures 6.2-1 through 6.2-8). As the project progresses through preliminary engineering and final design, MassDOT will strive to refine the design in an effort to further minimize property acquisitions and have the least possible impact on local neighborhood and property owners.

Constructing the Proposed Action as currently designed would require acquiring approximately 15.2 acres of land from 40 properties. The largest area acquisitions are for the project’s vehicle maintenance and storage facility in Somerville (four parcels totaling 10.2 acres). The most substantial acquisitions are those that displace and relocate active businesses. These are located at Ball Square (two businesses), Union Square (one business), and for the maintenance and storage facility site (one business). No residences would be displaced. Additional property acquisition information is provided in Section 6.2, *Land Use*.

Figure 4.4-18 Existing Section along Medford Branch Looking North

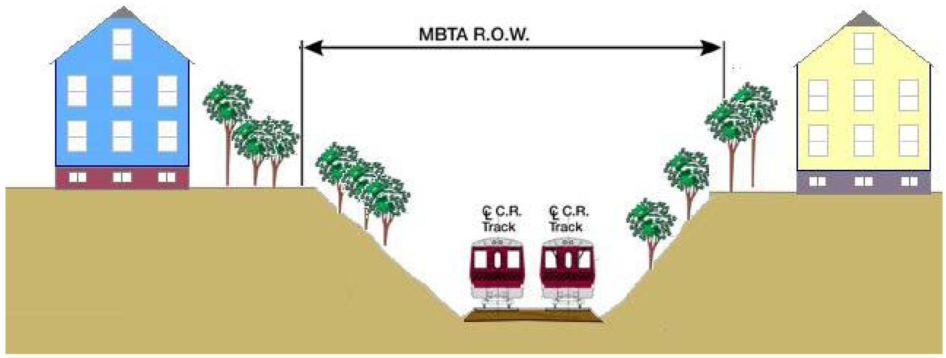
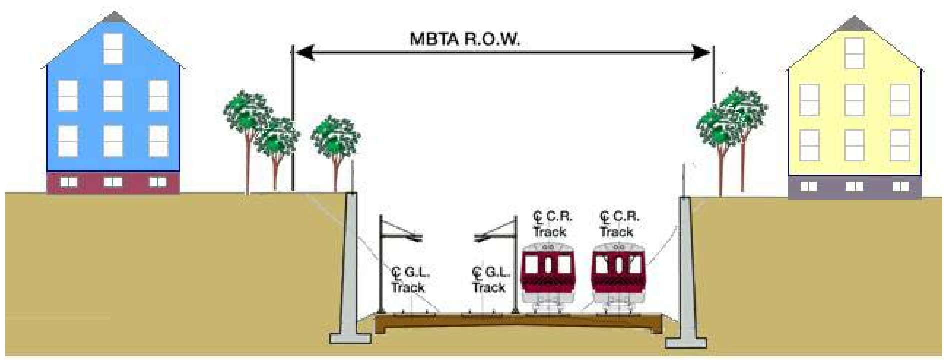



Figure 4.4-19 Proposed Section along Medford Branch Looking North




## 4.4.10 Construction Staging and Sequencing

Construction staging and sequencing strategies are critical to achieving the balance of an efficient construction project while minimizing the impacts to vehicular traffic, pedestrian traffic, on-street parking, public access, and emergency access to local businesses and residences. This corridor presents several construction challenges including narrow roadways, urban traffic volumes, and a variety of commercial, industrial, and residential land uses that require continuous access, limited space for construction zones and lay down areas within or near the rail corridor, and existing rail service that must be maintained throughout construction.

The use of the existing MBTA commuter rail right-of-way for the proposed Green Line tracks greatly reduces the complexity of construction as well as construction impacts. Figures 4.4-18 and 4.4-19 show the existing right-of-way and the proposed right-of-way along the Medford Branch. Where possible, bridges would be reconstructed to allow for early relocation of the existing commuter rail tracks. The existing cut would be widened by installing retaining walls on each side of the right-of-way and excavating the slopes. On the MBTA Lowell Line, the commuter rail tracks would be shifted to the east side of the widened cut, and the new Green Line tracks would be built along the west side. Most of the right-of-way is located below the surrounding land surface, reducing land acquisitions as well as environmental impacts such as noise and visual changes.

Bridge reconstruction would be staged whenever possible to maintain traffic over the respective bridges during construction. Construction staging would be required for roadway traffic as well as rail traffic beneath the bridge. In some cases, the existing bridge structure, the extent of reconstruction required on the bridge, and/or the proposed bridge structure are configured such that staged construction is not feasible and the bridge would have to be closed during construction. The project would limit bridge closures such that no two consecutive bridges would be closed at the same time. Detour plans would be developed in coordination with MassDOT and the affected cities.

The conceptual construction staging and sequencing address the constraints of the corridor, impacts to abutters, and other construction issues. More detailed evaluation and staging recommendations would be developed as design progresses and through coordination with the Cities of Cambridge, Somerville, and Medford, and the respective fire and police departments. This coordination would define restrictions that would be placed on the contractor, such as time of construction and construction zone set-up requirements, as well as maintenance of traffic and access to abutting properties.

Blasting is not anticipated for construction of the project. Rodent control policies would be included in construction management plans to prevent increased pest populations during the construction period. Likely measures would include good waste management (sealed trash containers, closed drains on dumpsters, etc.), fencing around long-term construction sites, and traps and/or baits as needed for any observed rodent problems. Construction procedures would comply with MassDEP's solid waste and air quality control regulations to prevent the spread of contaminated material or air quality impacts during construction.

The following measures would be incorporated during construction in order to minimize impacts to area residences and to provide management for traffic on area roadways and within the railroad right-of-way.

### Roadway

- Perform construction activities during day time hours whenever possible; avoid night time construction, particularly in residential areas;
- Restrict temporary lane closures to mid-week, off-peak traffic hours;

- Maintain one 11-foot travel lane in each direction except for short term, temporary closures;
- Allow detours, subject to approval of the respective municipality;
- Maintain pedestrian accessibility;
- Maintain access to all abutting properties;
- Maintain access for emergency vehicles through construction zones;
- Limit the length and duration of construction zones that would temporarily eliminate on-street parking;
- Limit the number of abutting construction zones where work is taking place simultaneously;
- Set up construction zones in accordance with industry standards (MUTCD) and municipal requirements, including police details, signage, variable message boards, temporary precast concrete barriers, drums, cones, etc;
- Coordinate with public safety departments and city officials;
- Maintain communication with the community concerning construction activities, lane restrictions, closures, locations of construction zones, etc;
- Limit bridge closures such that no two consecutive bridges would be closed at the same time and provide reasonable detour routes subject to municipal approval; and
- Isolate construction work zones from vehicular and pedestrian traffic with a temporary precast concrete barrier, drums, and/or cones.

### Rail

- Maintain commuter rail and freight traffic to the greatest extent possible (track outages are subject to approval of the MBTA);
- Provide flagmen for all work within the rail corridor;
- Limit track relocation work to off-peak hours; and
- Maintain minimum horizontal and vertical offsets from live track centerlines to work zones and structures.

### General Construction Sequence

Construction staging and sequencing would be coordinated to minimize the duration of detours and lane closures. The construction activities for this project would be performed in the following sequence to allow an efficient construction process while maintaining roadway and rail traffic in the area:

- Clear and grub, demolish buildings, and conduct any required remediation of contaminated soils;
- Clear and grub corridor;
- Temporarily relocate commuter rail lines as required;
- Construct retaining walls and initial bridges/abutments;
- Cut/rough grade corridor;
- Install corridor drainage system, utilities, signal conduit, etc. and construct remaining bridges;
- Construct station/platform foundations and footings;
- Install/rough grade light rail track bed;
- Install new outbound commuter rail track along east side of corridor;
- Relocate existing commuter rail track 1 to proposed commuter rail track 2 alignment;
- Construct off-site traffic improvements;
- Construct stations and platforms, OCS, etc;
- Install proposed Green Line tracks and landscaping;
- Construct bridges and walls south of Red Bridge;
- Construct new Lechmere Station; and
- Demolish existing Lechmere Station.

Typical construction sequence plans have been developed and are depicted in Figure 4.4-20. Close coordination with the MBTA; Cities of Cambridge, Somerville, and Medford; and the respective fire and police departments would address specific construction issues. The preliminary analysis of construction staging and sequencing shows that it is feasible to construct the project while maintaining rail operations, access to abutters, and traffic and pedestrian paths. As the design progresses, the traffic management details would be refined to better identify specific measures in specific areas, including detours. A comprehensive construction staging and sequencing plan would be developed and included in the final construction contract documents and communicated to the public.

### 4.4.11 Drainage and Utilities

Existing utilities and drainage facilities would be impacted temporarily or permanently throughout the project study area during construction due to the alignment of the proposed track, the proposed stations, and the placement of new OCS poles. Portions of the new track alignment are proposed over existing utilities and drainage facilities, which would be relocated to areas beyond the new track structure. This generally occurs where the proposed track alignment is over or adjacent to an existing utility. The drainage modifications would consist of reconstructing existing trunk lines along the corridor to avoid proposed track locations. Twelve-inch under drains would be installed along each side of the corridor with manholes every 300 feet, connected via lateral under drains to the trunk line. Detention/infiltration systems would be installed at proposed outfalls with a water quality treatment device. Other drainage modifications and adjustments expected at-grade would also occur at new wheelchair ramp locations to address conflicts with the new ADA compliant wheelchair ramps and where curb lines are shifting to accommodate turning lanes, bus zones, and pickup/drop-off areas.

Utility relocations and modifications could occur at isolated areas throughout the corridor. A preliminary evaluation of the utility impacts determined that the following utilities would be affected by the proposed work:

- Gas
- Water
- Sewer
- Drainage
- Electric
- Telephone
- Telecommunications

The following key utility features were found within or across the existing rail corridor:

- 48-inch drainage trunk line that conveys flow from the MBTA Lowell Line and the MBTA Boston Engine Terminal yard to the Charles River.
- 78-inch DCR sewer that passes under the right-of-way just north of 200 Inner Belt Road and conveys flow to Deer Island.
- 54-inch drain line that leaves the railroad right-of-way at Washington Street, follows Cobble Hill Road to Inner Belt Road and connects to the Old Stone culvert that discharges to the Millers River.
- 52-inch drainage trunk line leaves the railroad corridor south of School Street and connects to a 56-inch combined sewer outfall (CSO) that discharges to the Mystic River.
- An NSTAR substation located west of the corridor near the Somerville High School would likely be modified. During preliminary engineering, underground utilities leading into substation would be identified and verified to determine if the proposed work would require any reconstruction of the substation.

- 14-inch high pressure gas transmission line owned by AGT/Spectra that crosses under the tracks south of the Medford Street Bridge. This line was designed and constructed to prevent any relocations associated with the construction of the Green Line Extension project.
- The MWRA 48-inch water lines at College Avenue and Walnut Street are part of a redundant supply system. Work on the pipes should occur during low demand periods (September – May). Only one main can be taken out of service at any given time.

The following utility owners are known to have utilities in or around the corridor:

- Comcast
- CSX Railroad
- Lightower
- MCI Metro
- MWRA Sewer
- MWRA Water
- National Grid Electric
- National Grid Gas
- NSTAR Communications
- NSTAR Electric
- NSTAR Gas
- Somerville Department of Public Works
- Somerville Engineering
- Verizon
- Railroad Valuation Maps
- Algonquin Gas Transmission - Spectra Energy Corporation
- City of Medford
- City of Somerville
- City of Cambridge

Any utility relocations would occur in coordination with the respective owners of each utility. Utility coordination to date has been initiated with NSTAR and MWRA. Additional coordination with the above utility owners will occur during the preliminary engineering phase of the project.

## 4.5 Alternatives Considered but Dismissed

To identify the best scenario for meeting the transportation needs of the project study area in addition to the Proposed Action, MassDOT evaluated a Baseline Alternative and five Build Alternatives. The alternative selected as the LPA was Alternative 1, Green Line Extension to College Avenue and Union Square. The other alternatives evaluated and dismissed from further consideration were:

- Baseline Alternative – Enhanced, limited stop MBTA bus service in the project study area;
- Alternative 2 – Green Line Extension to Mystic Valley Parkway/Route 16 and Union Square (using commuter rail rights-of-way);
- Alternative 3 – Green Line Extension to Medford (at College Avenue, using commuter rail right-of-way) and Union Square (using McGrath Highway/Somerville Avenue);
- Alternative 4 – Green Line Extension to Mystic Valley Parkway/Route 16 (using commuter rail right-of-way) and Union Square (using McGrath Highway/Somerville Avenue);
- Alternative 5 – Green Line Extension to Mystic Valley Parkway/Route 16 (using commuter rail right-of-way); and
- Alternative 6 – Green Line Extension to Union Square (using commuter rail right-of-way).

Station alternatives and maintenance and storage facility alternatives that were evaluated and dismissed are also described later in this section.

### 4.5.1 Defining the Project Study Area

In order to determine the most appropriate alternatives for the Green Line Extension project, it was first necessary to evaluate the project study area in terms of feasible locations for stations and a maintenance and storage facility, as well as the viability of a Union Square spur.

During the development of the 2005 *Beyond Lechmere* MIS/AA, the alternative that evaluated light rail service (Alternative 1C) included an extension of service beyond the Mystic River to West Medford. The MIS/AA's proposed light rail alignment traveled via the MBTA Lowell Line alignment beyond Mystic Valley Parkway/ Route 16 and Mystic River to terminate at a location south of the existing West Medford Commuter Rail Station near High Street/Route 60. This termination point was determined to have a number of operational and environmental challenges, including an existing at-grade crossing and impacts to the historic Mystic Valley Parkway/Route 16 and Mystic River structures.

By extending the Green Line service across the Canal Street grade crossing, the existing two-track crossing would become a four-track crossing (two Green Line tracks; two commuter rail tracks). The differing operational characteristics of the Green Line, commuter rail, and roadway would raise safety concerns. In a similar situation in Los Angeles, the accident rates are much higher than the national average; 90 people have died on the Los Angeles County Metropolitan Transportation Authority's 22-mile Blue Line (consisting of 100 at-grade crossings). This line has had more than 821 recorded incidents between its inception in July 1990 and July 2008. All of the at-grade crossings in Los Angeles have grade crossings gates and lights.

Extending the Green Line to West Medford would also require widening the historic structures over the Mystic Valley Parkway/Route 16 and the Mystic River and could impact the parklands beneath the structures. If these structures were impacted, there would be an increased amount of environmental documentation and coordination that would be required, which could impact the ability to meet the project schedule and incur additional expenses. For these reasons, a variation of the Alternative 1C from the MIS/AA was proposed, with a project terminus south of the Mystic Valley Parkway/Route 16. The Secretary of the EEA specifically requested that the project evaluate a potential terminus in the vicinity of the Mystic Valley Parkway/Route 16. Thus, none of the Build Alternatives evaluated in the state environmental review process proposed extending service beyond Mystic Valley Parkway/Route 16.

### 4.5.2 Baseline Alternative Considered but Dismissed

The Baseline Alternative would add low-cost transit services that aim to provide a LOS comparable to the proposed Build Alternatives. The Baseline Alternative is enhanced, limited stop MBTA bus service in the project study area.

In place of the Medford Branch, the Baseline Alternative would enhance the existing MBTA Route 80 bus service. This service would operate parallel to the MBTA Lowell Line corridor. The Baseline Alternative would also include a new shuttle service that would be similar to the proposed Union Square Branch alignment. Fares for the Enhanced Route 80 service and for the Union Square shuttle service would match current MBTA subway fares using a Charlie Card, which were also assumed for the Build Alternatives: $1.70 for one-way adult trips, with free transfers to and from the Green Line.

The Enhanced Route 80 service would operate from Lechmere Station to Mystic Valley Parkway/Route 16. The Enhanced Route 80 would feature stop spacing that closely matches the proposed Green Line Medford Branch stations. The headways for the Enhanced Route 80 service would provide the same frequency of service as the proposed Green Line Extension Medford Branch.

The Baseline Alternative would also include a point-to-point shuttle bus service between Lechmere Station and Union Square using Monsignor O'Brien Highway/Route 28, McGrath Highway, and Somerville Avenue. This service would follow a similar route as the current Route 87 bus, with headways similar to the proposed Green Line Extension Union Square Branch.

Under the Baseline Alternative, the existing Green Line E branch would operate to Lechmere Station. It is also assumed that the existing Green Line D branch would be extended from Government Center Station to Lechmere Station, as the service has operated in the past. The Green Line D branch extension to Lechmere Station would double Green Line service frequencies at Lechmere Station and Science Park/West End Station. It would also increase Green Line frequencies within the Central Subway at North Station and Haymarket Station. The Baseline Alternative is expected to generate new systemwide transit ridership of 2,300 linked trips per day and a reduction of 8,834 VMT per day (projected to the year 2030). Figure 1.2-1 shows the conceptual route of the Baseline Alternative.

This Baseline Alternative was dismissed from further consideration because it does not meet the established purpose and need of the project.

## Enhanced Route 80 Service

The current MBTA Route 80 is a local route with service between Arlington Center in the Town of Arlington and Lechmere Station. The route is further described in Section 5.5.1, *Existing Bus Services*. The Enhanced Route 80 inbound service, intended to serve the Medford area initially, would begin its route near the intersection of College Avenue and Boston Avenue. It would travel south along College Avenue, Broadway, Medford Street, and McGrath Highway, terminating at Lechmere Station. Outbound service would follow the same corridor. The Enhanced Route 80 stations would be:

- Boston Avenue at College Avenue;
- Boston Avenue at Broadway;
- Medford Street at Broadway;
- Medford Street at School Street;
- Medford Street at Washington Street; and
- Lechmere Station.

Under the Baseline Alternative, the current Route 80 would continue to operate, serving the same local stops as it does under existing conditions. The following travel time, headway, and fare information for an Enhanced Route 80 service is provided for comparative purposes.

### Travel Time

According to current MBTA scheduling, it takes approximately 26 minutes for the Route 80 bus to travel the route from College Avenue to Lechmere Station, serving all scheduled stops between. In the spring of 2008, a field study was conducted, riding the Route 80 bus on several weekday commute peak hours, to identify travel times between stations. The actual travel times were occasionally shorter than the scheduled travel times, due to skipped stops at which there were no passengers. However, for the purposes of this study, the MBTA's published schedule was used as the basis for estimating the travel times for the Enhanced Route 80 service.

Table 4.5-1 Enhanced Route 80 Travel Times

| Period | Inbound (min) | Outbound (min) |
|---|---|---|
| AM Peak | 24 | 18 |
| Mid Day | 22.5 | 20 |
| PM Peak | 22 | 24 |
| Evening | 17 | 15 |

As shown in Table 4.5-1, the Enhanced Route 80 service traveling between Boston Avenue at College Avenue and Lechmere Station is estimated to have a travel time of approximately 22 to 24 minutes in the inbound direction and 18 to 24 minutes in the outbound direction during the peak periods. Compared to the current scheduled bus service travel time of 26 minutes, the Enhanced Route 80 service would offer an improvement of two to nine minutes.

### Headways

The headways of the Enhanced Route 80 would be adjusted to provide the same frequency of service as the proposed Green Line Medford Branch, while the headways on the existing Route 80 local bus would remain unchanged. The proposed headways for the Enhanced Route 80 service would be five minutes in the morning and evening peak periods and 10 minutes during off peak periods, closely matching the projected headway of the proposed Green Line Medford Branch. The headways of the existing Route 80 local bus service would remain at 20 minutes for the peak periods, 30 minutes for the midday period, and 60 minutes for the evening period.

### Fares

Fares for the Route 80 local service are based on the MBTA's local bus fare structure of $1.25 per one-way adult trip. Fares for the Enhanced Route 80 service are based on the MBTA's subway fare structure, which is $1.70 for each one-way adult trip and includes a free transfer to the subway.

## Union Square Shuttle

Under the Baseline Alternative, a point-to-point shuttle bus service would be introduced that makes a direct connection between Union Square and Lechmere Station. This shuttle would follow a similar route to the existing Route 87 bus, but without serving local stops. The current Route 87, which travels between Arlington Center in the Town of Arlington and Lechmere Station, is described in Section 5.5.1, *Existing Bus Service*. The proposed shuttle inbound service would begin its route at Union Square and follow Somerville Avenue and McGrath Highway to Lechmere Station. Outbound service would follow the same route.

The shuttle service would only serve two stops:

- Union Square
- Lechmere Station

The following travel time, headway, and fare information for a Union Square Shuttle is provided for comparative purposes.

## Travel Time

Similar to Route 80, the travel time for the existing Route 87 was obtained from the MBTA's schedule and validated by collecting field data. Travel time for the Route 87 bus between Union Square and Lechmere Station can take approximately seven to 17 minutes, depending on the time of the day. There are five existing stops on Route 87 between Union Square and Lechmere Station. As shown in Table 4.5-2, it is estimated that travel time for the enhanced shuttle service between Union Square and Lechmere Station with no intervening stops would take approximately 14 to 17 minutes in the inbound direction and five to nine minutes in the outbound direction during the peak periods, based on average bus speeds.

### Table 4.5-2 Union Square Shuttle Travel Times

| Period | Inbound (min) | Outbound (min) |
|---|---|---|
| AM Peak | 17 | 5 |
| Mid Day | 15 | 6 |
| PM Peak | 14 | 9 |
| Evening | 10 | 7 |

## Headways

The headways for the Union Square Shuttle would provide the same frequency of service as the proposed Green Line Union Square Branch. The existing Route 87 bus would continue to provide local service and operate with the same headways as the existing operations.

## Fares

Fares for the shuttle service connecting Union Square and Lechmere Station would be based on current MBTA subway fares: $1.70 for one-way adult trips. The shuttle service would include a free transfer to or from the Green Line at Lechmere Station.

### Capital Improvements

The Baseline Alternative would require the purchase of 19 standard, 40-foot transit buses and five new Green Line vehicles. Eleven buses would be required for the Enhanced Route 80 service, and five would be required for the Union Square shuttle. It is anticipated that three spare buses would also be purchased to support the service. It is assumed that these buses would be Emissions Control Diesel buses, consistent with the MBTA's plans for future bus procurements. The five new Green Line cars would be needed to service the extension of the existing Green Line D branch to Lechmere Station.

A new or an expanded existing bus facility would also be required. Based on the MBTA's bus program, the bus maintenance and storage facility should accommodate approximately 60 buses and be located in Somerville, and would require roughly the same amount of space as the maintenance and storage facility proposed for the Build Alternatives. Improvements to existing Lechmere Station would also be required in order to accommodate the additional buses needed to serve the Baseline Alternative.

### Conceptual Capital Costs

The estimate of conceptual capital costs was developed by conducting detailed quantity calculations of the various construction elements included in the conceptual design plans using 2008 unit prices. A 30 percent contingency was applied to the total construction cost to provide a level of confidence that the estimate presented at this stage reflects the true cost of the project. As the project moves forward into preliminary engineering and final design, the contingency would be reduced and replaced with costs that can be more accurately quantified through a more detailed design. Based on this evaluation, it is estimated that the conceptual capital cost of the Baseline Alternative for the facility, the new buses, and improvements to existing Lechmere Station would be approximately $146.2 million in 2008 dollars.

### Conceptual Operating & Maintenance Costs

Based on the MBTA's FY2008 Fully-Allocated Operating and Maintenance Cost Model with updates made utilizing the MBTA's most current financial information and calibrated to the year 2008, the conceptual operating and maintenance cost of the enhanced Baseline Alternative is estimated to be approximately $13.7 million per year in 2008 dollars.

## 4.5.3 Build Alternatives Considered but Dismissed

This section describes common elements of Build Alternatives 2 through 6 that were evaluated and have been dismissed from further consideration. This section also provides comparison of Build Alternatives 2 through 6 with the Proposed Action (Alternative 1).

### Build Alternative 2 – Extension to Mystic Valley Parkway/Route 16 and Union Square (using commuter rail rights-of-way)

Build Alternative 2 would provide Green Line service to Union Square and to Mystic Valley Parkway/Route 16 using a two-branch operation, both in existing commuter rail rights-of-way. The Medford Branch would extend from relocated Lechmere Station to Mystic Valley Parkway/Route 16 Station, following the MBTA Lowell Line right-of-way. Mystic Valley Parkway/Route 16 Station has been considered both with and without a 300-space parking structure. The Union Square Branch would follow the MBTA Fitchburg Line right-of-way to the Union Square area.

### Build Alternative 3 – Extension to Medford (using commuter rail rights-of-way) and Union Square (using McGrath Highway and Somerville Avenue)

Build Alternative 3 would provide Green Line service to Medford and Union Square using a two-branch operation. The Medford Branch would extend from relocated Lechmere Station to College Avenue along the MBTA Lowell Line right-of-way. The Union Square Branch would follow a one-way loop configuration from relocated Lechmere Station to Union Square along McGrath Highway and Somerville Avenue.

### Build Alternative 4 – Extension to Mystic Valley Parkway/Route 16 (using commuter rail right-of-way) and Union Square (using McGrath Highway and Somerville Avenue)

Build Alternative 4 would provide Medford Branch service to Mystic Valley Parkway/Route 16 using the MBTA Lowell Line right-of-way and Union Square Branch service using the one-way loop on surface streets. Alternative 4 includes a 300-space parking structure at the Mystic Valley Parkway/Route 16 Station.

### Build Alternative 5 – Extension to Mystic Valley Parkway/Route 16 (using commuter rail rights-of-way)

Build Alternative 5 would provide Green Line service to Mystic Valley Parkway/ Route 16 Station using a one-branch operation within the MBTA Lowell Line right-of-way. Both the existing Green Line D and E branches would extend along this corridor. Alternative 5 includes a 300-space parking structure at Mystic Valley Parkway/Route 16 Station. This alternative would not include a branch to Union Square.

## Build Alternative 6 – Extension to Union Square (using commuter rail rights-of-way)

Build Alternative 6 would provide Green Line service to Union Square using an one-branch operation within the MBTA Fitchburg Line right-of-way. Both the existing Green Line D and E branches would extend to Union Square. Alternative 6 would not include the Medford Branch.

## Comparison of Build Alternatives 2 through 6

This section provides for each dismissed build alternative: corridor distances, travel times, transit vehicle requirements, non-transit VMT reductions, estimated ridership, transportation impacts, and estimated costs.

### Alignment

#### Medford Branch

Each of the Build Alternatives would extend northwest from a relocated Lechmere Station, in either a one-branch or two-branch configuration. The Medford Branch would cross over the MBTA Fitchburg Line and meet the MBTA Lowell Line just past the proposed Washington Street Station, near Washington Street. The light rail corridor would then continue within the MBTA Lowell Line right-of-way. Like the Proposed Action, Alternative 3 would provide Medford Branch service to College Avenue. Alternatives 2, 4 and 5 would provide Medford Branch service farther to Mystic Valley Parkway/Route 16. Alternative 6 would not provide service to Medford.

#### Union Square Branch

The Union Square Branch would extend to a terminus near Union Square. This branch would follow either the MBTA Fitchburg Line right-of-way entirely, or follow a one-way loop from relocated Lechmere Station to Union Square along McGrath Highway and Somerville Avenue. The two Union Square options are roughly the same length. Similar to the Proposed Action, Build Alternatives 2 and 6 include the Union Square Branch entirely within the MBTA Fitchburg Line right-of-way. Build Alternatives 3 and 4 propose the one-way loop configuration for the Union Square Branch. Alternative 5 would not provide service to Union Square.

For Build Alternatives 2 and 6, near the crossing of the MBTA Fitchburg Line, a viaduct would convey the outbound Union Square Branch service over the MBTA Fitchburg Line. The viaduct would then touch down and outbound trains would cross under the Medford Branch and continue to travel west along the MBTA Fitchburg Line.

For Build Alternatives 3 and 4, which propose using the one-way loop configuration for the Union Square Branch, service would split from the MBTA Fitchburg Line right-of-way in the vicinity of the Monsignor O'Brien Highway/Route 28 overpass. Outbound service would travel through property that is currently privately owned and along a portion of McGrath Highway, connecting into Somerville Avenue. Here, tracks embedded in the pavement would allow in-street running along a low traffic volume portion of the roadway.

With both options, inbound Union Square Branch service would follow the MBTA Fitchburg Line right-of-way past McGrath Highway. A viaduct would then convey inbound trains over the MBTA Fitchburg Line to meet the Green Line Extension mainline. Inbound trains would then continue to Lechmere Station and Boston.

### Stations

Table 4.5-3 provides a comparison of proposed stations for the Build Alternatives. The Proposed Action and Alternatives 3 and 5 include seven stations. Alternatives 2 and 4 would have eight proposed stations. Alternative 6 would only provide service at two stations.

Table 4.5-3 Build Alternatives Comparison: Stations

| Alternative | Relocated Lechmere | Washington Street | Gilman Square | Lowell Street | Ball Square | College Avenue | Mystic Valley Parkway/Route 16 | Union Square |
|---|---|---|---|---|---|---|---|---|
| Proposed Action | X | X | X | X | X | X | | X |
| Alternative 2 | X | X | X | X | X | X | X | X |
| Alternative 3 | X | X | X | X | X | X | | X |
| Alternative 4 | X | X | X | X | X | X | X | X |
| Alternative 5 | X | X | X | X | X | X | X | |
| Alternative 6 | X | | | | | | | X |

### Travel Times

Table 4.5-4 provides a comparison of total corridor distance, and cumulative travel times for each of the Build Alternatives. Alternative 5 would be 4.3 miles long, similar to the Proposed Action. Alternatives 2 and 4 would have the longest corridor lengths at 5.2 and 5.7 miles respectively. The Proposed Action would produce the best cumulative travel times for both the Medford and Union Square Branches when compared to the other Build Alternatives.

**Table 4.5-4 Build Alternatives Comparison: Distances and Travel Times**

| Alternative | Total Corridor Distance (miles) | Cumulative Travel Time Medford Branch (minutes) | Cumulative Travel Time Union Square Branch (minutes) |
|---|---|---|---|
| Proposed Action | 4.3 | 9.5 | 4.5 |
| Alternative 2 | 5.2 | 12.0 | 4.5 |
| Alternative 3 | 4.8 | 9.5 | 6.0 |
| Alternative 4 | 5.7 | 12.0 | 6.0 |
| Alternative 5 | 4.3 | 12.0 | NA |
| Alternative 6 | 0.9 | NA | 4.5 |

### Headways

Headways at Lechmere Station would be the same for the Baseline Alternative and each of the Build Alternatives. Both the Green Line D and E branches would extend service from their current northern termini to connect to Lechmere Station. The Green Line D branch service operates every five minutes in the morning and evening peak periods and every 10 minutes during off-peak periods. Green Line E branch service operates every six minutes in the morning peak period, every five minutes in the evening peak period, and between nine and 10 minute intervals during off-peak periods. The combined headways at Lechmere Station would provide station service every three minutes in the morning and evening peak periods and every five minutes during off-peak periods.

The Build Alternatives present some variation of service northwest of Lechmere Station. For Alternatives 2, 3 and 4, the Green Line D branch would extend along the Medford Branch and the E branch would extend along the Union Square Branch. For Alternative 5, both the Green Line D and E branches would extend along the Medford Branch. For Alternative 6, both the Green Line D and E branches would extend along the Union Square Branch.

### Fares

For Build Alternatives 2 through 6, fares would be equal to MBTA subway fares, currently $1.70 for one-way adult trips using a Charlie Card.

### Vehicle Requirements and Conceptual Costs

Table 4.5-5 provides a comparison of the vehicle requirements, estimated new daily system linked trips (2030), estimated daily VMT Reduction (2030) and conceptual cost estimates for each Build Alternative.

**Table 4.5-5 Alternatives Comparison: Vehicle Requirements, Ridership and Conceptual Costs**

| Alternatives | Rail Transit Vehicle Requirements | Estimated New Daily System Linked Trips (2030)[1] | Estimated Daily VMT Reduction (2030)[1] | Conceptual Cost Estimates: Capital ($millions 2008)[2] | Conceptual Cost Estimates: Operating and Maintenance ($millions/year 2008)[2] |
|---|---|---|---|---|---|
| Baseline | 19[3] | 2,300 | 8,834 | $146.2 | $13.7 |
| Proposed Action (Alternative 1) | 24 | 7,500 | 25,728 | $804.8 | $21.3 |
| Alternative 2 (w/ parking) | 27 | 8,900 | 26,556 | $959.3 | $27.3 |
| Alternative 2 (no parking) | 27 | 8,600 | 26,647 | $951.8 | $27.3 |
| Alternative 3 | 23 | 7,700 | 27,895 | $829.8 | $22.1 |
| Alternative 4 | 27 | 8,700 | 32,005 | $984.3 | $24.5 |
| Alternative 5 | 33 | 10,500 | 33,206 | $870.0 | $28.2 |
| Alternative 6 | 0 | 3,900 | 9,604 | $370.6 | $8.1 |

1 New ridership is based on projections to year 2030 and the difference between future No-Build Conditions for the Green Line and the future Build Conditions with the Green Line Extension project in place.

2 The most recent cost estimates were calculated in 2011 dollars for the Proposed Action only. In 2011 dollars, the capital cost for the Proposed Action is estimated at $971 million and operating and maintenance costs of $24.5 million per year.

As shown in Table 4.5-5, all of the Build Alternatives except for Alternative 6 are projected to provide a considerable increase in the estimated daily system ridership and/or a considerable decrease in the daily VMT. The Proposed Action has been recommended because it best meets the project needs, including increased ridership and reduced daily VMT, while also minimizing the need for property acquisitions and relocations and the environmental impacts to the project study area and surrounding environs. Section 4.7, *Summary*, provides a discussion of the relative benefits of the Proposed Action, and describes why it has been selected as the LPA.

During the development of the DEIR/EA, 10 percent design concept plans for the Proposed Action and detailed capital cost estimates were developed. The capital improvements include, but are not limited to, construction of track, stations, structures, systems, drainage, utilities, and the maintenance facility. Additional costs include property acquisitions and business relocations as well as vehicle acquisition and professional services. The cost of the Proposed Action includes the cost to relocate Lechmere Station. The overall cost of the Proposed Action is currently estimated to be approximately $971 million in 2011 dollars, including $82 million for 24 additional Green Line vehicles, plus finance charges. Annual operating and maintenance costs would be approximately $24.5 million in 2011 dollars. The total costs for the Proposed Action were further refined to include inflation for the time period in which the project is to be implemented (2019). YOE capital costs for the Proposed Action were calculated to be approximately $1.1 billion in YOE dollars, plus finance charges.

## 4.5.4 Station Alternatives Considered but Dismissed

In addition to the seven proposed station sites, alternate station locations were evaluated during an extensive screening site selection process.

Alternative station locations were evaluated in the vicinity of Union Square, based upon the various alternative alignments for the light rail extension to Union Square. The station location on Somerville Avenue proposed as part of the Union Square in-street running alternative alignment was dismissed from further consideration as it created impacts to the area traffic and roadway network. MassDOT selected the Union Square alternative alignment within the MBTA Fitchburg Line right-of-way along with the associated station location at Prospect Street.

MassDOT also evaluated siting the Medford Branch station between Winthrop Street and College Avenue. Station locations at Winthrop Street and a location in between College Avenue and Winthrop Street were evaluated and dismissed from further consideration. A thorough station siting evaluation was performed for all possible options in this vicinity; this evaluation is presented in Appendix H, *Station and Alignment Selection Analysis*. MassDOT ultimately dismissed both of these alternative station locations in favor of a station site just north of College Avenue.

MassDOT was also directed to evaluate the potential for co-locating a new commuter rail station with a Green Line station along the Medford Branch. In order to allow for providing a commuter rail station along the MBTA Lowell Line, it would be necessary to fully comply with the accessibility requirements for commuter rail stations, as well as to accommodate the requirements for freight service along the corridor. The MBTA Lowell Line currently accommodates freight rail service in addition to passenger rail service and is designated as a "high-and-wide route," meaning that additional clearances are required for freight traffic along the corridor. Given the impacts on area residential properties that would result from a joint commuter rail-light rail station, this alternative was dismissed and not advanced for further consideration.

## 4.5.5 Maintenance and Storage Facility Alternatives Considered but Dismissed

The area referred to as "Yard 8 with Adjacent Parcel" (Yard 8) was initially selected as the preferred location for the construction of a Green Line vehicle maintenance and storage facility, based on the site's size, configuration, and adjacency to the proposed Green Line Extension tracks. The selection of the Yard 8 site prompted local opposition from some municipal officials, elected representatives, and abutting residents. To resolve these concerns, MassDOT qualitatively analyzed two additional possible sites for the facility in December 2009.[5] Option L, a site identified by MassDOT, is immediately

5 Massachusetts Department of Transportation. *Green Line Extension Project, Additional Maintenance Facility Alternatives Analysis Technical Memorandum*. December 9, 2009. Available at: www.mass.gov/greenlineextension.

adjacent to the MBTA commuter rail maintenance facility, also referred to as the MBTA Boston Engine Terminal. Mirror H, a site proposed by the City of Somerville, straddles the Inner Belt area of Somerville and the NorthPoint area of Cambridge.

The December 2009 *Additional Maintenance Facility Alternatives Analysis*[6] included an analysis of operations, property acquisition needs, and schedule implications, as well as a preliminary evaluation of potential environmental impacts and costs. This qualitative analysis concluded that both Yard 8 and Option L remained viable locations for the Green Line Extension project support facility, while the Mirror H site rated lower in a number of categories.

Following an extensive public review and comment period on the DEIR/EA, the January 15, 2010 MEPA Certificate required MassDOT to prepare a FEIR for the Green Line Extension project, including a more detailed, quantitative analysis of the environmental and operational impacts associated with Option L and Mirror H. In response, MassDOT conducted that analysis as documented in the April 2010 *Environmental Analysis of Additional Maintenance Facilities*.[7] The full environmental analysis for Yard 8 is provided in this technical report for comparison purposes.

After balancing all operational and environmental benefits and impacts of the three maintenance and storage facility alternatives, combined with discussions with the local communities, MassDOT identified Option L as the preferred maintenance facility site for the Green Line Extension project.

## 4.6 New Starts Criteria and Status Update

MassDOT has committed Commonwealth funding for the project and is pursuing FTA's Section 5309 New Starts Program for additional funding. In November 2007, MassDOT submitted a preliminary New Starts initiation package to the FTA. Since that time, MassDOT has continuously coordinated with the FTA and their Project Management Oversight Consultants (PMOC) and has submitted additional documentation to demonstrate the need and benefits of this proposed investment.

The FTA New Starts program is the Federal government's primary financial resource for supporting locally planned, implemented, and operated transit guideway capital investments. After first meeting the planning, environmental, and project management requirements, candidate projects seeking to advance through project development are subject to FTA evaluation against the New Starts project justification and local financial commitment criteria.

6 *Ibid.*

7 Massachusetts Department of Transportation. *Green Line Extension Project, Environmental Analysis of Additional Maintenance Facilities Technical Memorandum.* April 21, 2010. Available at: www.mass.gov/greenlineextension.

Because MassDOT is seeking to fund the project in part by the FTA New Starts program, it is essential that the Proposed Action meets the New Starts criteria measures as defined by the FTA's procedural and technical guidance.[8]

A summary of the Proposed Action as compared to the Baseline Alternative and the major New Starts criteria, including ridership, user benefit hours, and cost-effectiveness, is provided in Table 4.6-1.

Table 4.6-1 Summary of New Starts Criteria for the Proposed Action

| Alternatives | Daily Project Boardings | Annual Project Boardings | Daily User Benefit Hours [1,2] (Hours) | Cost-Effectiveness [2] ($/User Benefit Hour) |
|---|---|---|---|---|
| Proposed Action | 24,280 | 7,114,040 | 7,549 | $31.01 |

Source: Central Transportation Planning Staff
1 User Benefit is measured in hours of transportation user benefit per year as calculated by SUMMIT, a travel demand forecasting software created by the FTA and required to be used on all New Starts projects.
2 Both the User Benefit Hours and the Cost-Effectiveness for the Proposed Action are measured as compared to the Baseline Alternative.

## 4.7 Summary

The Green Line Extension project evaluated a No-Build Alternative, a "Baseline" Alternative (which includes corridor transportation improvements not including a fixed-guideway transit improvement), and six "Build" Alternatives. Four of the Build Alternatives would provide service to both Medford and to Union Square in Somerville; one Build Alternative would provide service to Medford only (terminating at Mystic Valley Parkway/Route 16); and one Build Alternative would provide service to Union Square only.

Alternative 1, Green Line Extension to Medford and Union Square (using commuter rail rights-of-way), was selected as the Proposed Action for the Green Line Extension project because it provides a balance of cost, ridership, and environmental impacts. This alternative would help the Commonwealth achieve its goal of providing expanded transportation services and improved regional air quality. The Proposed Action would meet all project goals, would be operationally practical, and would generate a considerable number of new systemwide transit trips.

The Proposed Action has been fully analyzed for its environmental impacts. The following chapters of this EA discuss the impact that the Green Line Extension project (the Proposed Action) would have on the surrounding environment as well as the proposed mitigation commitments to alleviate these impacts.

8 United States Department of Transportation, Federal Transit Administration. *New Starts Guidance*. Available at: http://www.fta.dot.gov/planning/newstarts/planning_environment_213.html

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# 5

# Affected Environment

## 5.1 Introduction

This chapter discusses the existing conditions of human and environmental resources that may be affected by the Green Line Extension project. Evaluated resources include: land use; socioeconomic conditions; environmental justice populations; transportation systems; traffic; air quality; noise; vibration; stormwater; parks and recreation areas; visual environment; historic and archeological resources; and hazardous materials. Environmental resources not present within the project study area include wetlands; floodplains; fish, wildlife and plants (including threatened and endangered species); sensitive environmental resources; and wild and scenic areas.

Figure 1.1-1 shows the project study area and project study corridor, and Figures 5.1-1 through 5.1-9 show the project study corridor and the surrounding neighborhoods at a larger scale, including local landmarks and specific resources. The potential impacts of the project on the resources and conditions described in this chapter are assessed in Chapter 6, *Environmental Consequences*.

## 5.2 Land Use

This section provides an overview of the existing land use conditions in the proposed Green Line corridor from Cambridge to Somerville and Medford; the existing zoning around each proposed station site; and recent land use plans and studies in the project study area. Specific infrastructure projects that may affect land uses in the project study area are also described.

### 5.2.1 Overview

Historically, the MBTA's Lowell Line (also known as the New Hampshire Mainline) served Boston and points north and west with freight rail operations. Beginning in the 1830s, the route proved popular, and, by the 1840s, a second set of tracks and local passenger service were added. Service extended as far as Montreal, Canada.

Boston and Maine Railroad (B&M) acquired the line in 1895. In the mid to late twentieth century, the demand for passenger and freight rail services declined as automobiles and trucks became the preferred mode of transport. The current commuter service starts at North Station and terminates in Lowell, Massachusetts, although there are plans to extend the service to Nashua, New Hampshire.

The MBTA Fitchburg Line originally operated as the Fitchburg Railroad, beginning in the 1840s. Service extended from Boston into New York State, with termini in Saratoga and Troy. B&M leased the line in 1900 and then purchased the railroad in 1919, and it was sold to the MBTA in 1976. Passenger service on the line currently terminates in Fitchburg.

Today, the project study area contains a mix of commercial and industrial uses adjacent to the railroad corridor. Residential uses are interspersed in various structural types but are largely wood frame, multi-family and single-family homes. The area is densely settled and well established with the greatest suburban growth occurring in the late industrial period (1870-1915). Very few houses in the project study area were built after the 1920s.

While the project study area is nearly completely built out with little vacant land, there are major redevelopment proposals in the eastern portion that could change the development character in some locations. Some of the proposals have elements of transit-oriented development (TOD) that could generate additional transit ridership beyond that which would be expected from traditional development.

Based on the 2000 U.S. Census,[1] the combined population of the three municipalities affected by the project study area was 234,909 in 2000 and the combined land area is 19.7 square miles. This yields a relatively high population density of 11,930 persons per square mile. The total population within a one-half mile radius of the seven proposed station sites was 74,711 in 2000. Similarly the combined at-place employment in the three municipalities was 152,029 and within a one-half mile radius of the station sites was 31,706. Together, this high concentration of population and employment makes for an excellent, transit-supportive corridor.

Major activity centers in the project study area include:

- The Lechmere area in east Cambridge that includes Middlesex County courts and other governmental facilities as well as commercial uses, a large regional shopping mall, high density (mid-rise and high rise) housing, hotels, and one of the region's most popular tourist attractions, the Boston Museum of Science;
- The Somerville City Center, which includes City Hall, the high school, and the main public library;

1 Metropolitan Area Planning Council, 2000 United States Census data and population, household, and employment data by Transportation Analysis Zone (TAZ) 2000-2030, August 2008.

- Tufts University in Medford and Somerville, an educational institution with over 8,500 students; and
- Union Square in Somerville, a neighborhood business district with historic roots.

In between these major activity centers are smaller centers such as Cobble Hill near Washington Street Station, and Ball Square in Somerville.

### 5.2.2 Existing Land Use at Proposed Station Sites

This section describes the existing land uses within a one-half mile radius of the proposed station sites. This distance is considered the typical distance riders are willing to walk to a station. If TOD were to be approved, it would likely be sited within one quarter mile from a station. Figure 5.2-1 shows a one-quarter mile radius overlay on Transportation Analysis Zones (TAZ), quantitatively presented in Tables 5.2-1 through 5.2-7 in accordance with FTA methodology.[2] Figures 5.2-2 through 5.2-8 show the one-quarter and one-half mile land use study areas assessed for each proposed station location.

#### Relocated Lechmere Station, Cambridge

The relocated Lechmere Station site is along an abandoned former B&M railroad spur (owned by MBTA) on the east side of the Monsignor O'Brien Highway/Route 28, near the Glass Factory Condominiums (Figures 5.1-1 and 5.2-2). The existing Lechmere Station (over 6,400 boardings daily[3]) is nearby on the west side of Monsignor O'Brien Highway/Route 28.

East of the station is the NorthPoint development project, which when built out will include mixed-use and multi-family residential buildings and a 5-acre central park with connections to the planned Somerville Community Path. The first phase, which includes two residential buildings (329 units), garaged parking, and the central park, was completed in August 2008.

Farther east and adjacent to the NorthPoint project is the Archstone-Smith residential development. Phase I, which includes 437 rental units, was completed in 2007. Phase II is permitted for 426 units.

West of the site is the Hampton Inn Hotel. Behind the hotel at 22 Water Street are vacant buildings slated for redevelopment by Catamount Holdings into 392 residential units, parking, and open space.

2 United States Department of Transportation, Federal Transit Administration, Office of Planning and Environment. *Reporting Instructions for the Section 5309 New Starts Criteria (FY2011)*, Appendix A: Sample Methodology for Estimating Station Area Socio-Economic, July 2009. Available at: http://www.fta.dot.gov/documents/Release_FY11_Reporting_Instructions.pdf

3 Massachusetts Bay Transportation Authority. *Ridership and Service Statistics* (*Blue Book, Twelfth Edition*), 2009. Available at: http://www.mbta.com/uploadedfiles/documents/Bluebook%202009.pdf Data from 2008 automated fare collection.

The one-half mile radius zone around the relocated Lechmere Station site contains mostly railroad and industrial uses to the northeast, including the MBTA's main commuter rail maintenance facility (the MBTA Boston Engine Terminal) in Somerville. The areas south and west of the station are fully developed, with older, dense residential neighborhoods to the west, a mix of older and newer commercial development to the south and west along Cambridge Street, and an area of parking lots and mostly one-story industrial buildings along the periphery of the zone to the south.

Several mid- to high-rise brick structures are along the Charles River embankment and the Lechmere Canal, including the 900,000-square foot CambridgeSide Galleria Mall, Thomas Graves Landing condominiums, Regatta Riverview Apartments, and the Royal Sonesta Hotel. The Boston Museum of Science is southeast of the station on the Charles River Dam.

Despite the dense development activity along the Cambridge waterfront and at NorthPoint, the overall housing density in this area is moderate at 7,413 units per square mile in 2010. However, area density has been growing and is projected to increase to 10,927 units per square mile in 2030, as shown in Table 5.2-1. The employment density in this area is the highest in the project study area.

**Table 5.2-1 Population, Housing and Employment within One-Half Mile Radius of the Relocated Lechmere Station Site**

| | Estimate | Projections[1] | |
|---|---|---|---|
| | 2000 | 2010 | 2030 |
| Population | 7,150 | 9,940 | 13,925 |
| Population density (persons/square mile) | 9,735 | 13,533 | 18,959 |
| Households | 3,651 | 5,445 | 8,026 |
| Housing density[2] (units/square mile) | 4,971 | 7,413 | 10,927 |
| Employment | 13,959 | 16,545 | 20,115 |
| Employment density (jobs/square mile) | 19,005 | 22,526 | 27,387 |

Source: Based on one-half mile radius overlays on TAZs 1, 21-22, 198, 203-204, 579-582, and 625-637 as depicted on Figure 5.2-1.

1 Derived from population, household, and employment by TAZ 2000-2030, MAPC, August 2008. Densities are rounded to nearest whole number.

2 Number of households is used as an estimate for the number of housing units in the project study area.

## Washington Street Station, Somerville

The proposed Washington Street Station site is at the junction of residential and industrial areas. The site is within the existing MBTA right-of-way at the Washington Street railroad bridge in Somerville (Figures 5.1-4 and 5.2-3). The station headhouse would be under the bridge abutment, directly under the elevated Green Line tracks. The area between McGrath Highway/Route 28 and the proposed Green Line corridor, which is called the Brickbottom District, has a number of small businesses in a mix of old and new multi-story and single-story structures. The station side of Washington Street includes an auto repair shop, Iron Mountain Storage, school bus parking, the Herb Chambers Mercedes-Benz dealership, and the Joy Street artist studios.

Farther south, on Fitchburg Street, are the 150-unit Brickbottom Artists Buildings, which consist of two five-story masonry structures (Figure 5.1-2). Northeast of the station on Washington Street is the Cobble Hill apartment community for senior citizens and the Cobble Hill neighborhood convenience center. A mid-rise hotel frames the Cobble Hill neighborhood on its east side.

A mix of older and newer developments along the north side of Washington Street include Cataldo Ambulance, a diner, a tattoo parlor, and other small commercial establishments mixed in with some older, wood-frame residential buildings. Housing nearest the station includes a mix of multi-family homes and apartments, single family homes, and the Cobble Hill apartments.

Adjacent and east of the railroad corridor near the station are a four-story brick office building occupied by Fine Arts Storage Partners at 200 Inner Belt Road, a railroad yard known as Yard 8 that was used by PanAm Railways until recently for Boston distribution, and a large vacant parcel.

The northern portion of the one-half mile radius zone from the Washington Street Station site consists of moderately dense, older multi-family residential neighborhoods. Glen Street Park, with a playing field, basketball courts, and a playground is nearby. The southeast quadrant of the zone between McGrath Highway/Route 28 and I-93 is mostly industrial. This area includes the Inner Belt District, a 90-acre site that was cleared in the 1960s for the Inner Belt Highway (which was never constructed). It was redeveloped in the 1960s and 1970s with mostly single-story industrial, warehouse and distribution facilities, and is slated for redevelopment as a mixed-use district.

West of the site along Somerville Avenue is Union Square, which includes a mix of commercial, industrial, and multi-family residential uses. Two major shopping centers with large parking lots are nearby: Twin City Plaza southeast of the site, and the Target/Circuit City shopping center, southwest of the site. Schools within the one-half mile radius include the Prospect Hill Academy Charter School and the East Somerville Community School.

Station area housing density is moderate but has been growing, as shown in Table 5.2-2. The employment density is low, compared to near the relocated Lechmere Station, but is projected to increase over the long term.

**Table 5.2-2 Population, Housing and Employment within One-Half Mile Radius of the Washington Street Station Site**

| | Estimate | Projections[1] | |
|---|---|---|---|
| | 2000 | 2010 | 2030 |
| Population | 6,984 | 7,980 | 9,248 |
| Population density (persons/square mile) | 14,091 | 16,101 | 18,659 |
| Households | 2,673 | 3,245 | 4,069 |
| Housing density[2] (units/square mile) | 5,393 | 6,548 | 8,209 |
| Employment | 3,823 | 4,552 | 5,558 |
| Employment density (jobs/square mile) | 7,715 | 9,184 | 11,214 |

Source: Based on one-half mile radius overlays on TAZs 205, 579-583, 587-590, 604-606, 629, and 646 as depicted on Figure 5.2-1.
1 Derived from population, household, and employment by TAZ 2000-2030, MAPC, August 2008. Densities are rounded to nearest whole number.
2 Number of households is used as an estimate for the number of housing units in the project study area.

## Gilman Square Station, Somerville

The proposed Gilman Square Station site is within the MBTA Lowell Line right-of-way north of the Medford Street Bridge. The station headhouse would be on the east side of the tracks, across the tracks from the Somerville City Center complex. The site is adjacent to an unused City-owned property on Medford Street (Figures 5.1-5 and 5.2-4). West of the site is a steep embankment rising up to the Somerville High School, City Hall, and Public Library. East of the site on Pearl Street and Medford Street are commercial buildings; a parking lot; a dense, multi-family residential neighborhood of wood frame homes; the six-story brick Pearl Street Park apartment community; and a small landscaped park.

The one-half mile radius zone around the site is comprised of mostly dense, older multi-family residential neighborhoods of wood-frame homes. Highland Avenue has some three- to six-story brick apartment buildings and townhouses, and several architecturally distinctive homes. A 10-story apartment building is adjacent to the City Hall complex. Concentrations of one- and two-story brick commercial buildings are along Highland Avenue to the south and Broadway to the north, and auto-oriented strip development exists along McGrath Highway/Route 28 north of Broadway.

Schools within the one-half mile radius include the adjacent Somerville High School, the Winter Hill Community School and, near the periphery, the Full Circle High School and the Capuano Early Education Center. The former Cummings School south of the site was closed but is temporarily being used by the East Somerville Community School as it rebuilds following a 2007 fire. The Central Street Health Center is on the eastern periphery of the zone.

The housing density is the highest in the project study area, reflecting the number of low- and mid-rise apartment buildings within walking distance of the station, as shown in Table 5.2-3.

**Table 5.2-3 Population, Housing and Employment within One-Half Mile Radius of the Gilman Square Station Site**

| | Estimate | Projections[1] | |
|---|---|---|---|
| | 2000 | 2010 | 2030 |
| Population | 15,158 | 15,272 | 15,193 |
| Population density (persons/square mile) | 25,058 | 25,246 | 25,115 |
| Households | 6,099 | 6,191 | 6,323 |
| Housing density[2] (units/square mile) | 10,082 | 10,234 | 10,453 |
| Employment | 2,462 | 2,661 | 2,935 |
| Employment density (jobs/square mile) | 4,070 | 4,399 | 4,853 |

Source: Based on one-half mile radius overlays on TAZs 588, 590-591, 598-602, 604-608, and 610-611 as depicted on Figure 5.2-1.

1 Derived from population, household, and employment by TAZ 2000-2030, MAPC, August 2008. Densities are rounded to nearest whole number.

2 Number of households is used as an estimate for the number of housing units in the project study area.

## Lowell Street Station, Somerville

The proposed Lowell Street Station site is in a residential neighborhood at the Lowell Street Bridge (Figures 5.1-6 and 5.2-5). Immediately west of the site is a large redevelopment project. Two industrial buildings were removed and construction is underway on the MaxPac Square residential development (199 units, with below ground parking and open space). South of the site on Lowell Street is the large, three-story wood-frame Visiting Nurses Assisted Living Community (97 apartments) with associated parking, and an adjacent auto body shop. Farther south on Central Street is a four-story brick industrial complex, an apartment building, and a small park. North of the site is Magoun Square, which has a mix of retail, restaurant, and other business uses in one- and two-story brick buildings along Medford Street. Other commercial concentrations are along Broadway to the west and Highland Avenue to the south. Northwest of Magoun Square, the Somerville Public Works Department has a maintenance facility comprised of one- and two-story brick and masonry buildings. North beyond the public works facility are the Trum Playground and the baseball diamonds of Trum Fields.

The area in the one-half mile radius zone around the site is mostly dense, multi-family residential neighborhoods of older, two-family, wood frame homes and three-deck homes. The Benjamin G. Brown School, Saint Catherine of Genoa, and the Winter Hill Community School are near the periphery of the zone. Somerville Hospital is south of the station.

The housing density is second highest in the project study area, as shown in Table 5.2-4, because of the large multi-family structures and apartment buildings. The employment density is low compared to other station sites, reflecting the residential character of this neighborhood.

**Table 5.2-4 Population, Housing and Employment within One-Half Mile Radius of the Lowell Street Station Site**

| | Estimate | Projections[1] | |
|---|---|---|---|
| | 2000 | 2010 | 2030 |
| Population | 12,604 | 13,027 | 13,443 |
| Population density (persons/square mile) | 22,767 | 23,530 | 24,282 |
| Households | 5,346 | 5,587 | 5,934 |
| Housing density[2] (units/square mile) | 9,657 | 10,092 | 10,718 |
| Employment | 1,962 | 2,071 | 2,220 |
| Employment density (jobs/square mile) | 3,544 | 3,740 | 4,011 |

Source: Based on one-half mile radius overlays on TAZs 550, 598, 601-603, 607, 611-616 as depicted on Figure 5.2-1.
1 Derived from population, household, and employment by TAZ 2000-2030, MAPC, August 2008. Densities are rounded to nearest whole number.
2 Number of households is used as an estimate for the number of housing units in the project study area.

## Ball Square Station, Somerville/Medford

The proposed Ball Square Station site is on Boston Avenue at the Broadway Bridge, near the heart of Ball Square (Figures 5.1-7 and 5.2-6). The area is a developing neighborhood commercial center, with mostly older, one- and two-story brick and wood-frame commercial buildings. The commercial strip along Broadway includes several popular restaurants, and a variety of older and newer retail establishments and services. The area around the site on Boston Avenue is more industrial, with parking lots and newer one-story brick and wood-frame buildings including commercial buildings that front Broadway. The area farther north along Boston Avenue is residential, with a large, newer wood-frame, multi-family housing complex on the east side of the street and older wood-frame, two-family homes on the west side. Beyond are the Saint Clement Parish schools, a gas station, more homes, and several industrial buildings.

The one-half mile radius zone consists of primarily multi-family residential neighborhoods of older wood-frame, two-family homes with some three-deck homes, but also includes a number of playing fields (Trum Fields, Tufts Park, Tufts Alumni Fields, and Powder House Square fields) and the Tufts University stadium. Several schools are nearby (Somerville's Benjamin G. Brown School to the southwest, and Medford's Curtis-Tufts Alternative School and Christopher Columbus School). Concentrations of commercial development are at Magoun Square to the south, along Boston Avenue to the northwest, and on Medford Street to the northeast. Tufts

University is at the periphery of the zone to the north, and Davis Square at College Avenue and Highland Avenue is just beyond the zone to the southwest.

The housing density is moderate, and the employment density is low, as shown in Table 5.2-5.

**Table 5.2-5 Population, Housing and Employment within One-Half Mile Radius of the Ball Square Station Site**

| | Estimate | Projections[1] | |
|---|---|---|---|
| | 2000 | 2010 | 2030 |
| Population | 9,209 | 9,426 | 9,659 |
| Population density (persons/square mile) | 18,217 | 18,646 | 19,108 |
| Households | 3,588 | 3,770 | 4,032 |
| Housing density[2] (units/square mile) | 7,098 | 7,458 | 7,976 |
| Employment | 1,663 | 1,743 | 1,855 |
| Employment density (jobs/square mile) | 3,289 | 3,449 | 3,669 |

Source: Based on one-half mile radius overlays on TAZs 550-553, 555, 603, 612, 615-616, 619-621 as depicted on Figure 5.2-1.

1 Derived from population, household, and employment by TAZ 2000-2030, MAPC, August 2008. Densities are rounded to nearest whole number.

2 Number of households is used as an estimate for the number of housing units in the project study area.

## College Avenue Station, Medford

The proposed College Avenue Station site is in Medford, near the intersection of Boston Avenue and College Avenue (Figures 5.1-8, 5.1-9, and 5.2-7). To the west of the site are several Tufts University properties, including a five-story brick public parking garage/student services center, the edge of a campus green, and another five-story brick campus building and a parking lot. Tufts' Alumni Fields and gymnasium are east of the site. Moderately dense residential uses are north and east of the site. Neighborhood commercial uses, many oriented to college students, are along Boston Avenue on the south side of College Avenue and also north near Winthrop Street. Older one- and two-story commercial buildings are south of the site on Boston Avenue and east of the station on Medford Street.

The one-half mile radius zone includes large tracts of two-family and three-deck homes. West of the site is the Tufts University campus on College Hill, with its diverse set of old and modern buildings arranged along a series of campus greens. The one-half mile radius includes the West Somerville Neighborhood School and the Saint Clement Parish elementary school.

The housing density is moderate, and the employment density is low, as shown in Table 5.2-6.

**Table 5.2-6 Population, Housing and Employment within One-Half Mile Radius of the College Avenue Station Site**

| | Estimate | Projections[1] | |
|---|---|---|---|
| | 2000 | 2010 | 2030 |
| Population | 10,552 | 10,666 | 10,795 |
| Population density (persons/square mile) | 15,959 | 16,132 | 16,327 |
| Households | 3,194 | 3,355 | 3,588 |
| Housing density[2] (units/square mile) | 4,831 | 5,075 | 5,426 |
| Employment | 2,502 | 2,630 | 2,807 |
| Employment density (jobs/square mile) | 3,784 | 3,978 | 4,246 |

Source: Based on one-half mile radius overlays on TAZs 552-558, 619-621, and 623 as depicted on Figure 5.2-1.
1 Derived from population, household, and employment by TAZ 2000-2030, MAPC, August 2008. Densities are rounded to nearest whole number.
2 Number of households is used as an estimate for the number of housing units in the project study area.

## Union Square Station, Somerville

The proposed Union Square Station site is in the MBTA Fitchburg Line right-of-way with access from Prospect Street (Figures 5.1-3 and 5.2-8). Several land uses intersect at the site, with the shops and restaurants of Union Square to the north, the commercial/industrial Boynton Yards complex to the south, and a multi-family residential neighborhood to the east. The site also includes a masonry supplier and a scrap metal operation.

To the north of the site is Union Square, with a municipal parking lot and several one- and two-story brick and wood-frame structures containing commercial businesses. Bow Street has a number of commercial blocks of three- and four–story buildings. Somerville Community Access Television is in a two-story, historic brick firehouse with a bell tower in the center of Union Square, and the Somerville Public Safety building is in a one-story brick building to the northeast on Washington Street. The adjacent Boynton Yards is south of Union Square on the south side of the Fitchburg line right-of-way along the southern border of Somerville. Boynton Yards, which was formerly a meat packing and rail yard district, is now under development as an industrial area. The Prospect Hill Academy Charter School and the Dr. Albert F. Argenziano School are west of Union Square.

The one-half mile radius zone includes Inman Square in Cambridge with several restaurants; a commercial district with one- and two-story shops and restaurants along Cambridge Street; a shopping center west of the station on Somerville Avenue; and industrial areas east of McGrath Highway/Route 28 and on the western periphery of the zone. The remainder of the zone consists of multi-family residential neighborhoods of two-family houses and triple-deck homes, with several architecturally distinctive single-family houses to the north on Prospect Hill. Prospect Hill is also the site of a park overlooking the square with the remnants of a military fortification from the American Revolution and a castellated monument constructed in 1903.

The housing density is relatively high, and the employment density is second highest in the project study area, as shown in Table 5.2-7.

**Table 5.2-7 Population, Housing and Employment within One-Half Mile Radius of the Union Square Station Site**

| | Estimate | Projections[1] | |
|---|---|---|---|
| | 2000 | 2010 | 2030 |
| Population | 13,055 | 13,976 | 15,167 |
| Population density (persons/square mile) | 23,601 | 25,265 | 27,419 |
| Households | 5,497 | 5,903 | 6,489 |
| Housing density[2] (units/square mile) | 9,937 | 10,672 | 11,730 |
| Employment | 5,335 | 5,510 | 5,752 |
| Employment density (jobs/square mile) | 9,645 | 9,961 | 10,398 |

Source: Based on one-half mile radius overlays on Transportation Analysis Zones (TAZs) 582-585, 605-608, 629, 646-649, 651, 661-662, and 676-677 as depicted on Figure 5.2-1.

1 Derived from population, household, and employment by TAZ 2000-2030, MAPC, August 2008. Densities are rounded to nearest whole number.

2 Number of households is used as an estimate for the number of housing units in the project study area.

## 5.2.3 Zoning

This section provides a description of existing zoning near the proposed station sites. Figure 5.2-9 shows a generalized zoning plan for the communities of Cambridge, Somerville, and Medford. The plan is derived from the Massachusetts Geographical Information System (MassGIS) Primary Use mapping, which shows the highest density type of development permitted.

At the east end of the project study area, the zoning is predominantly industrial. The zoning changes to business/commercial west of the proposed Washington Street Station site, then to predominantly residential west of the proposed Gilman Square Station site to the proposed Medford Branch terminus at College Avenue. The spur to Union Square is zoned for industrial uses in the existing Lechmere Station area and for residential and business uses at the proposed Union Square Branch terminus in Union Square. A more detailed description of the zoning in the vicinity of the proposed station sites is provided below.

### Relocated Lechmere Station, Cambridge/Somerville/Boston

Zoning in the Cambridge portion of the relocated Lechmere Station area is Planned Unit Development (PUD). The purpose of a PUD is to provide for a mix of uses at designated locations at greater variety, density, and intensity than would normally be allowed under traditional zoning. PUDs also are intended to maximize pedestrian TOD.

The proposed relocated Lechmere Station site is in Cambridge's NorthPoint Residence District PUD. Zoning in the NorthPoint Residence District is primarily residential, with retail, office uses, and community services encouraged. The 5.1 acres of NorthPoint land within the City of Somerville are zoned Industrial B. The land in Boston that is adjacent to Somerville's NorthPoint land is zoned as a Local Industrial Subdistrict.

The existing Lechmere Station site is in a multi-family residential district and a Cambridge PUD overlay district. This district is intended to provide the opportunity for development of highly active, medium density commercial, and residential areas with a mix of retail, office, and residential uses.

Zoning south of the proposed station site is for a variety of land uses that include residential, business, open space, and industrial. Areas closest to the station are zoned for business and multi-family dwellings. Extending farther away is a mix of zones: multi-family dwellings, general business, open space, east Cambridge Riverfront PUD, and industrial.

### Washington Street Station, Somerville

The proposed Washington Street Station site is between an area zoned for general commercial and high density residential and industrial. Generally, land zoned for industrial use is southeast of the site. The remainder of land near the site is zoned for various residential types that include one- and two-family homes, medium density neighborhoods of one-, two- and three-family homes, and multi-family residential.

### Gilman Square Station, Somerville

The proposed Gilman Square Station site is in an area predominantly zoned for residential uses. Immediately north of the site is a commercial district. Multi-family residential use lies directly south of the site. Land zoned for one- and two-family homes and medium density neighborhoods of one-, two- and three-family homes is in the surrounding area of the site with some small parcels zoned as neighborhood business districts.

### Lowell Street Station, Somerville

The proposed Lowell Street Station site is in an area primarily zoned for residential uses. The site is zoned for medium density one-, two- and three-family homes, and land near the site is zoned for one- and two-family homes and medium density one-, two- and three-family homes, and some multi-family residential. Northwest and southeast of the station are parcels zoned for industrial use. Parcels zoned for general commercial and high density residential and neighborhood business districts are in outlying areas of the station.

### Ball Square Station, Somerville/Medford

The proposed Ball Square Station site is in an area predominantly zoned for residential uses. On the Somerville side, the site is in a location zoned as a neighborhood business district, with a small parcel of land zoned for a commercial district to the east. Parcels zoned for one- and two-family homes and medium density one-, two- and three-family homes are prevalent near the site. On the Medford side, land in the area is zoned for general residence.

### College Avenue Station, Medford

The proposed College Avenue Station site is in an area zoned for residential use with land zoned for general residence to the east and single family homes to the north. A large parcel zoned as a University District lies south of the station in Somerville. Land is zoned for one- and two-family homes southeast of the station.

### Union Square Station, Somerville

The proposed Union Square Station site area contains a wide range of zoning districts. The station itself would be in a commercial district. To the north, land is zoned for one- and two-family homes and a commercial residential district. An industrial district lies to the east and a central business district is to the west.

There are many zoning districts to the south that include one-, two- and three-family homes, an industrial park district, and a commercial district with a PUD Overlay District.

## 5.2.4 Land Use Plans

This section describes recent land use plans, studies, and design guidelines that affect development in the project study area in Cambridge, Somerville, and Medford. The discussion is presented by each proposed station site.

### Lechmere Station Area Plans

Area plans in the vicinity of the Lechmere Station are described below. Additional information is provided in Section 6.2.4, *Consistency with Proposed Transportation Projects*.

The East Cambridge Planning Team (ECPT) is an independently incorporated neighborhood association that works to enhance the quality of life and the environment in the neighborhood of east Cambridge. ECPT advocates for the community on issues concerning urban planning, commercial and residential development, preserving and creating green and open space, city policy, community safety, and access to resources and services that benefit residents. It strives to build a strong and lively community by supporting neighbors, local businesses, and cultural and social service organizations. ECPT collaborates with local partners to host informational forums and family friendly events. ECPT meetings are open to everyone, although only residents of east Cambridge may vote.

The *East Cambridge Neighborhood Study Update* (Fall 2006), prepared by Cambridge's Community Development Department, reported that eastern Cambridge Rezoning was adopted in 2001. The rezoning allows for mixed-use development in commercial and former industrial districts, which includes NorthPoint. Specifically, a "two-tiered" system of base zoning and overlay zoning regulations was established. Base zoning was lowered and the PUD approach was adopted to allow for increased development opportunities.

The *Eastern Cambridge Design Guidelines: NorthPoint* (December 2003), prepared by Spaulding and Slye Colliers International, are intended for use by architects designing buildings in NorthPoint. The guidelines envision a new mixed-use district with a variety of parks and public spaces. Creating a retail edge at the relocated Lechmere Station is a design goal. Additionally, the station area is envisioned to serve as a gateway to NorthPoint.

The *NorthPoint Somerville Planning Study* (February 2003), prepared by ICON Architecture, reviewed potential opportunities and impacts of Cambridge rezoning and the NorthPoint development on adjacent areas in Somerville. The study also included a vision for the region beyond NorthPoint, including the Inner Belt District, the Green Line Extension, and the Somerville Community Path. The study concluded that the proposed development in NorthPoint could provide a unique opportunity for the City to redevelop the Inner Belt into a productive district of mixed-use development to increase employment opportunities. In order to achieve this goal, the study provided three recommendations: changes in zoning such as increasing building height and density limits; improving vehicular access from all directions; and implementing the Green Line Extension project.

The *Eastern Cambridge Planning Study* (October 2001), prepared for the Cambridge Community Development Department, analyzed existing conditions, opportunities and constraints for eastern Cambridge. NorthPoint is envisioned as a mixed-use neighborhood with housing as a dominant land use, and land in close proximity to Lechmere Station is viewed as prime area for development. TOD is encouraged.

### Washington Street Station Area Plans

The City of Somerville is conducting a master planning process for the Inner Belt area, from Monsignor O'Brien Highway to I-93. The City views this area as an opportunity for redevelopment, with potential for high-rise and mixed-use development.

Dimella and Schafer Consultants is conducting a master planning process for Cobble Hill, a 10-acre site on Washington Street. Cobble Hill is approximately one-quarter mile east of the proposed Washington Street Station on the east side of the MBTA Lowell Line. Mixed-use development is envisioned for this site, which currently contains 400 senior housing units.

The City of Somerville has had preliminary discussions with The Kraft Group, owners of the New England Patriots and the New England Revolution, about the possibility of constructing a 20,000-seat Major League Soccer Stadium in the Inner Belt area. Proximity to a stop on the proposed Green Line Extension is a key factor in the discussion. The Kraft Group is contributing $150,000 toward a study of the development potential in the Brickbottom district and the Inner Belt Area.

### Gilman Square Station Area Plans

Several studies have been conducted for the redevelopment of the Homan's Building (formerly referred to as the Reid and Murdock Warehouse building) at 350 Medford Street, a 53,600-square foot building on a 1.11-acre site owned by the City of Somerville. The building is on the east side of the MBTA Lowell Line, at the site of the proposed Gilman Square Station. The City envisions redevelopment for use as artist live/work/study space.

Planners in the City of Somerville noted that there is potential for existing auto mechanic/commercial uses along Walnut Street to be converted to residential use. Walnut Street crosses the MBTA Lowell Line approximately one-quarter mile east of the proposed Gilman Square Station.

### Lowell Street Station Area Plans

The proposed Lowell Street Station site is adjacent to the MaxPac Square site, a 199-unit residential development currently under construction on 5.49 acres on the west side of the MBTA Lowell Line. Two vacant industrial buildings, at 56 and 61 Clyde Street, were demolished to allow for the new development. The MaxPac

Square site is between the MBTA Lowell Line and an inactive rail spur (the former freight cut-off through Davis Square). Prior to construction, the developer removed the railroad tracks and ties between Cedar Street and Lowell Street to build a temporary construction road, which is anticipated to be later utilized by the Somerville Community Path. Construction began on the first two MaxPac Square units in late 2010.

### Ball Square Station Area Plans

Neither the City of Medford nor the City of Somerville has active development projects, ongoing or planned studies, or rezoning plans at the proposed Ball Square Station location.

### College Avenue Station Area Plans

The City of Medford does not have active development projects, ongoing or planned studies, or rezoning plans at the proposed College Avenue Station location.

Tufts University is considering the addition of a new Integrated Lab Complex on Boston Avenue south of the proposed College Avenue Station, and several other new structures along Boston Avenue, for an estimated 913,000 square feet of new development or additions to existing facilities. The construction of these buildings would require razing two existing industrial buildings at 550 and 574 Boston Avenue. These concepts were shown in the *Tufts University Master Plan: A Vision for the Future* by Tufts University and William Rawn Associates as part of the University's 2006 Master Plan.

### Union Square Station Area Plans

In April 2009, the City of Somerville Board of Aldermen approved six new zoning districts in the Union Square/Boynton Yards vicinity. These districts provide height and density limits appropriate for TOD near the proposed Green Line station. The new districts are intended to establish a more transit and pedestrian-oriented neighborhood. Key elements included: advancing economic development around under-used parcels with a mix of commercial and housing uses; fostering active, pedestrian-oriented first floor uses, with arts and culture; and preserving the district's historic architecture.

The changes include three new types of zoning districts for Union Square: TODs in the vicinity of the proposed Green Line Extension station; a Commercial Corridor District along Somerville Avenue, Washington Street, and parts of Bow, Prospect, and Webster Streets; and an Arts Overlay District that covers the Commercial Corridor District and beyond.

The TOD and Commercial Corridor District zoning amendment provides increased development densities. In the TODs, the maximum building heights were increased from 50 feet to a range of 55-135 feet and the Floor Area Ratios (FAR)[4] were increased from 2.0 to a range of 3.0 to 5.5. In the Commercial Corridor District, the maximum building height was increased from 50 feet to 55 feet and the FAR from 2.0 to 3.0. The current maximum building height in the Union Square Central Business District is 50 feet.

The City of Somerville has designated two buildings as Priority Development Sites: the old Public Safety Building (228 Washington Street) and the Kiley Barrel site (266 Somerville Avenue). The City envisions redeveloping these buildings as primarily commercial with some residential use. Anticipated development in this area is projected to be more than 300,000 square feet and up to 100 feet in height, with an FAR of 4.0.

The City is preparing an in-house master plan and transportation plan for Boynton Yards. Abutting the south side of the MBTA Fitchburg Line, Boynton Yards is approximately 10 acres south of the proposed Union Square Station site. The City envisions development in Boynton Yards to be high-end residential, commercial and laboratory with retail uses on the ground floor.

Somerville's *Five-Year Consolidated Plan for 2008-2013* (February 2008), prepared by the Department of Community Planning and Development, includes the Neighborhood Revitalization Strategy Area (NRSA) for Union Square. NRSAs are specially designated areas within a community that, based upon approval by the U.S. Department of Housing and Urban Development (HUD), allow for increased flexibility to program HUD Community Development Block Grant Funds. The Union Square NRSA was initially adopted in 2002.

In 2007, the City began working on a *Development Implementation Strategy for Union Square*. This study recommends specific action steps to advance development in Union Square. The study analyzed several public-private partnerships that could be used as models for the City's development efforts in Union Square. This report ties further into the District Improvement Financing analysis by making recommendations of needed infrastructure improvements to facilitate development.

The *Somerville Community Development Plan* (June 2004), prepared for the Office of Housing and Community Development, addressed extending the Green Line to Medford Hillside with the inclusion of a Union Square Alternative. The plan envisions multi-modal transit stations at Union Square, Gilman Square, and Ball Square. Development of access plans and new zoning are identified to encourage TOD.

4 Floor Area Ratio is a unitless number equal to the total building square footage divided by the site square footage.

The *Union Square Master Plan* (April 2003) was prepared for the City of Somerville, Office of Housing and Community Development. The Master Plan designated three key redevelopment sites: the Citizens Bank Block (on Bow Street between Stone Avenue and Warren Street); the South Side of Somerville Avenue (between Prospect Street and Webster Avenue); and the Prospect Street Corridor TOD.

In anticipation of the Green Line Extension, the Master Plan recommended that new major development sites be within an easy walking distance (1,200 to 1,500 feet) from the intersection of Prospect Street and Webster Avenue. New office development and affordable housing were encouraged in Union Square. Where appropriate, infill was recommended along the approach corridors (Somerville Avenue and Washington Street) to the east and west of the district core.

Reuse of city properties for new office, retail and housing was addressed in the Master Plan. Potential locations include the old Bow Street Police Station, Old Union Square Fire Station/Somerville Community Access Television Building, and the Recreation Commission Building. Opportunities to "green" the Square by converting small privately owned parcels to pocket parks are also addressed.

The *Union Square Transportation Plan* (September 2002) was prepared for the City of Somerville, Office of Housing and Development. One of the plan's objectives was to create a more livable urban village by balancing traffic improvements with urban design initiatives, parking improvements and mass transit opportunities. The plan also supported and gave recommendations for implementing TOD.

The *Union Square Revitalization Study/Neighborhood Revitalization Strategy Area Plan* (2002), prepared by the City of Somerville, serves as part of the City's Five Year Consolidated Plan and Phase One of a Master Plan for Union Square. The plan promoted creating office space, research and development facilities; developing additional small scale retail uses; maintaining the Square's focus as a restaurant destination; encouraging uses related to arts and entertainment; and developing a reuse plan for the former Bow Street Police Station.

## 5.3 Socioeconomic Conditions

The existing socioeconomic conditions in Cambridge, Somerville, and Medford, focusing on employment and income in each city, are described below.

Cambridge, Somerville, and Medford are among 20 cities and towns in the Metro North Workforce Area, as defined by the Massachusetts Executive Office of Labor and Workforce Development. Between the first quarters of 2009 and 2010, the seasonally unadjusted unemployment rate increased from 6.5 percent to 7.9 percent in the Metro North region, while unemployment for Massachusetts as a whole increased from 8.2 percent to 9.9 percent.[5] This trend indicates that the Metro North region continues to be affected by the impacts of the recent economic downturn.

Growth projections indicate that the Massachusetts economy is expected to generate 216,650 net new jobs (a 6.3 percent increase) between 2006 and 2016, with an additional 768,330 existing jobs becoming available due to retirement and other career changes. Population growth between the April 2000 U.S. Census and July 2009 was 3.9 percent for Massachusetts as a whole. During this same time, the Metro North population decreased by 2.6 percent, including a 7.4 percent increase in Cambridge, negligible (less than 0.1 percent) increase in Medford, and a 1.6 percent decrease in Somerville. Table 5.3-1 summarizes social and economic statistics for Cambridge, Somerville, and Medford.

**Table 5.3-1 Social and Economic Statistics for Cambridge, Somerville and Medford**

| City | Population | Population (per square mile) | Rental Housing[1] | Units in Multi-family Buildings[1] | Median Household Income | Per Capita Income | Unemployment Rate[2] | Poverty Rate[2] |
|---|---|---|---|---|---|---|---|---|
| Cambridge | 101,355 | 15,770 | 67.8% | 85.3% | $47,979 | $31,156 | 6.1% | 11.1% |
| Somerville | 77,478 | 18,874 | 69.4% | 88.1% | $46,315 | $23,628 | 3.5% | 12.1% |
| Medford | 55,765 | 6,888 | 41.3% | 61.5% | $52,476 | $24,707 | 3.6% | 6.1% |

Source: U.S. Census data (2000).
1 Rates expressed as percent of total occupied housing units.
2 Rates expressed as percent of population.

## 5.3.1 Cambridge

Cambridge is a very densely populated city with approximately 15,770 residents per square mile. The majority of Cambridge housing is in rental units (67.8 percent of all units) and in multi-unit buildings (85.3 percent of all units), which can include multi-family homes and apartment buildings. According to the 2000 U.S. Census, Cambridge has approximately 101,355 residents, with 59,965 of these (59.2 percent) listed as eligible workers. Of these, 3,668 workers were unemployed in 2000 — a 6.1 percent overall unemployment rate. Median household income in Cambridge was $47,979, with a per capita income of $31,156. Approximately 11.1 percent of the population was below the poverty line, and 18.5 percent of the population was classified as low income by state environmental justice standards, defined as less than 65 percent of the statewide median household income. In 2000, median household income in Massachusetts was $46,753, making the environmental justice household income threshold approximately $30,389.

5 Commonwealth of Massachusetts Executive Office of Labor and Workforce Development. *Regional LMI Profile: Annual Profile for Metro North Workforce Area*, May 2010. Available at: http://archives.lib.state.ma.us/handle/2452/50365

Approximately 25.1 percent of Cambridge workers commute to work on public transportation. The largest employers in Cambridge are its educational institutions, Harvard University and the Massachusetts Institute of Technology. Health care and biotechnology firms also make up an important segment of the Cambridge economy.

Lechmere Station is in the neighborhood of east Cambridge. The rest of the project would take place outside of Cambridge, although parts of the proposed Green Line Extension would be within walking distance of North Cambridge and the Wellington/Harrington neighborhood.

### 5.3.2 Somerville

Somerville is the most densely populated city in New England with approximately 18,874 residents per square mile. The majority of Somerville housing is in rental units (69.4 percent of all units) and in multi-unit buildings (88.1 percent of all units).

Somerville has a larger population than Medford and a lower unemployment rate, but it has the lowest median and per capita income of the three cities. According to the 2000 U.S. Census, Somerville has approximately 77,478 residents, with 47,656 of these (61.5 percent) listed as eligible workers. Of these, 1,661 workers were unemployed in 2000 — a 3.5 percent overall unemployment rate. Median household income in Somerville was $46,315, with a per capita income of $23,628. Approximately 12.1 percent of the population was below the poverty line, and 8.6 percent of the population was classified as low income by state environmental justice standards.

Approximately 29.2 percent of Somerville workers commuted to work on public transportation. The numerous educational institutions within Somerville and in nearby cities play an important role in the City's economy. While both Harvard University and much of Tufts University are physically located outside of Somerville, many students and employees of these institutions live in Somerville or make use of its amenities. The proposed Green Line Extension would provide service to several Somerville neighborhoods, including those surrounding Ball Square, Union Square, Gilman Square, and Winter Hill.

### 5.3.3 Medford

Medford has a much lower population density than Cambridge and Somerville with approximately 6,888 residents per square mile. However, Medford neighborhoods near proposed Green Line stations have higher population densities than the city on a whole. Less than half of Medford housing consists of rental units (41.3 percent of all units), although the majority of Medford housing is in multi-unit buildings (61.5 percent of all units), as is true in Cambridge. Medford has a smaller population than Cambridge and a lower per capita income but also has higher household incomes and lower poverty and unemployment rates.

According to the 2000 U.S. Census, Medford has approximately 55,765 residents, with 30,133 of these (54.0 percent) listed as eligible workers. Of these, 1,088 workers were unemployed — a 3.6 percent overall unemployment rate. Median household income in Medford was $52,476, with a per capita income of $24,707. Approximately 6.1 percent of the population was below the poverty line, and 5.8 percent of the population was classified as low income by state environmental justice standards.

Approximately 18.1 percent of Medford workers commute to work on public transportation. Medford is the official location of Tufts University, although much of the campus is in Somerville. The University is a major factor in the local economy and employs many area residents.

## 5.4 Environmental Justice Populations

This section describes the regulatory context of environmental justice in transportation planning and discusses the environmental justice populations in Cambridge, Somerville, and Medford.

### 5.4.1 Regulatory Context

A range of Federal orders, rules, and regulations define environmental justice populations, require assessment of impacts to those populations, and establish standards for minimizing impacts.

Environmental justice is concerned with the impacts of services and Federal funding on defined minority and low-income populations. Executive Order 12898[6] requires specific examination of environmental and human health effects on minority populations and low-income populations for all Federal projects to ensure that these groups are not disproportionately affected.

U.S. DOT Order 5610.2,[7] applicable specifically to the FTA as well as other U.S. DOT projects, defines a disproportionately high and adverse effect on minority and low-income populations as "an adverse effect that (1) is predominately borne by minority population and/or a low-income population, or (2) will be suffered by the minority population and/or low-income population and is appreciably more severe

6 Clinton, President William J. Executive Order 12898: *Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations*. The White House: Washington, DC, February 11, 1994. Available at: http://www.archives.gov/federal-register/executive-orders/pdf/12898.pdf

7 United States Department of Transportation. 1997. *Department of Transportation Order to Address Environmental Justice in Minority Populations and Low-Income Populations.* Federal Register Vol. 62, No. 72, April 15, 1997. Departmental Office of Civil Rights and Office of the Assistant Secretary for Transportation Policy. Available online at http://www.fhwa.dot.gov/ejustice/dot_ord.htm. Accessed October 15, 2010.

or greater in magnitude than the adverse effect that will be suffered by the non-minority population and/or non-low-income population."

Environmental justice compliance must be demonstrated for both Federal and state standards. Rather than using set, nation-wide minority or income thresholds for environmental justice, the U.S. DOT methodology requires examining the social makeup of any affected areas (usually based on 2000 U.S. Census data, the most recent currently available) to ensure that low-income and minority populations do not bear a disproportionate share of the effects of a project. On the state level, environmental justice is usually analyzed by comparing U.S. Census data to thresholds for income, race, and ethnicity data established by the state, municipality, or MPO to define minority, foreign-born, and low-income populations.

In Massachusetts, EEA has established the *Environmental Justice Policy*[8] in an effort to protect the environment and public health of the Commonwealth. EEA's environmental justice policy is based upon the principle that all people have the right to be protected from environmental pollution and to live in and enjoy a healthful environment. MassGIS mapping developed by the EEA is used to determine if an area meets the criteria of an environmental justice population for low-income, foreign-born, and minority populations. The assessment of environmental justice populations for the Green Line Extension project provided in this section is based both on local demographics and on the Massachusetts definition of environmental justice populations, which is more conservative than the Federal methodology by including a foreign-born (combined with English language proficiency) criterion in addition to income and race.

### 5.4.2 Existing Conditions

Cambridge, Somerville, and Medford all have environmental justice areas, defined as areas meeting foreign-born, minority, or low-income population criteria. Most of both Cambridge (52.7 percent) and Somerville (68.5 percent) consist of environmental justice areas by at least one criterion, while less than a quarter of Medford (22.2 percent) is considered an environmental justice area. The majority of these areas are due to large foreign-born or minority populations. Table 5.4-1 summarizes these areas for each city.

8 Commonwealth of Massachusetts, Executive Office of Energy and Environmental Affairs. *Environmental Justice Policy of the Massachusetts Office of Energy and Environmental Affairs.* Boston, 2002. Available at: http://www.mass.gov/Eoeea/docs/eea/ej/ej_policy_english.pdf

### Table 5.4-1 State-Listed Environmental Justice Areas in Cambridge, Somerville and Medford

| | Fraction of City Area Designated as Environmental Justice Area[1] | | | |
|---|---|---|---|---|
| | Defined by | Defined By Specific Criteria | | |
| City | Any Criteria | Foreign-Born | Minority | Income |
| Cambridge | 52.7% | 41.9% | 51.0% | 12.1% |
| Somerville | 68.5% | 52.7% | 45.8% | 15.8% |
| Medford | 22.2% | 7.4% | 14.9% | 4.8% |

Source: U.S. Census data (2000), MassGIS.

1 Environmental justice areas can be designated based on multiple independent criteria. The table presents the cumulative environmental justice areas for all criteria as well as the total area designated by the specific criteria indicated.

The state-defined environmental justice populations in the vicinity of the project study area are shown in Figure 5.4-1. Nearly all of the proposed Green Line Extension is adjacent to one or more environmental justice population.

Due to variations in urban density, the portion of the population living in environmental justice areas differs somewhat from the geographic extent of environmental areas alone. Approximately 71.1 percent of Cambridge residents live in environmental justice areas, as do 66.7 percent of Somerville residents and 30.7 percent of Medford residents. More than half of Cambridge and Somerville residents are foreign-born. Table 5.4-2 summarizes the environmental justice populations in each city.

### Table 5.4-2 Summary of Environmental Justice Populations in Cambridge, Somerville and Medford

| | Fraction of City Population Living in Environmental Justice Areas[1] | | | |
|---|---|---|---|---|
| | Defined by | Defined By Specific Criteria | | |
| City | Any Criteria | Foreign-Born | Minority | Income |
| Cambridge | 71.1% | 50.3% | 68.6% | 18.5% |
| Somerville | 66.7% | 56.6% | 48.8% | 8.6% |
| Medford | 30.7% | 11.2% | 20.8% | 5.8% |

Source: U.S. Census data (2000), MassGIS.

1 Environmental justice areas can be designated based on multiple independent criteria. The table presents the cumulative environmental justice areas for all criteria as well as the total area designated by the specific criteria indicated.

Table 5.4-3 lists the racial breakdown of each city as a whole. All three cities have predominantly white populations, with varying proportions of black, Asian, multiracial, and Hispanic residents. The most common minority in Cambridge are of Asian origin (12.0 percent), followed by black (11.9 percent) and Hispanic (7.3 percent) populations. Hispanics are the most common minority in Somerville (8.6 percent), followed by Asians (6.5 percent) and blacks (6.4 percent). Medford has the highest proportion of white residents (86.5 percent), with smaller black (5.9 percent), Asian (4.2 percent), and Hispanic (2.5 percent) percentages than the other two cities. By comparison, Middlesex County as a whole shares a similar racial breakdown with Medford, with a high proportion of white residents (85.8 percent) with smaller black (3.3 percent), Asian (6.3 percent), and Hispanic (4.5 percent) percentages than Cambridge or Somerville.

**Table 5.4-3 Minority Populations in Cambridge, Somerville, Medford and Middlesex County**

| | | Percentage of Population by Race | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| City | Total Population | White | Black | Native American | Asian | Pacific Islander | Other | Multiracial | Hispanic[1] |
| Cambridge | 101,355 | 68.1% | 11.9% | 0.4% | 12.0% | 0.0% | 3.0% | 4.6% | 7.3% |
| Somerville | 77,478 | 77.0% | 6.4% | 0.4% | 6.5% | 0.1% | 4.9% | 4.8% | 8.6% |
| Medford | 55,765 | 86.5% | 5.9% | 0.2% | 4.2% | 0.0% | 1.1% | 2.1% | 2.5% |
| Middlesex County | 1,465,396 | 85.8% | 3.3% | 0.2% | 6.3% | 0.0% | 2.1% | 2.3% | 4.5% |

Source: U.S. Census data (2000), MassGIS.

1 Hispanic populations are generally included as subsets within the other racial categories but are listed separately as well for clarity. Therefore, the percentages for each city would add up to more than 100 percent.

All three cities are in Middlesex County and rank below the county averages for median household income ($60,821) and per capita income ($31,199), although Cambridge's per capita income ($31,156) is very close to the county average. Cambridge and Somerville, with 11.1 percent and 12.1 percent of the population below the poverty level, respectively, both have nearly double the county poverty rate of 6.5 percent, while Medford's poverty rate is just below the county average at 6.1 percent. These statistics indicate that these three cities combined comprise a somewhat economically disadvantaged segment of the Middlesex County economy. Many of these differences may be due to the relatively affluent suburban character of other Middlesex County cities and towns to the north that benefit from the region's high levels of employment and job growth but have lesser economic burdens from urban development and municipal infrastructure.

Overall, these data indicate that the cities within the Green Line Extension project have a fairly dense, low-income, minority residential population.

## 5.5 Transportation Systems

The following sections describe the existing transportation systems within the project study area, including bus service, commuter rail, freight rail, roadways and traffic, as well as bicycle and pedestrian facilities.

### 5.5.1 Existing Bus Services

This section discusses existing bus services within the project study area. The MBTA operates 15 bus routes in the project study area. Tufts University offers campus shuttles in the area. A Massachusetts Institute of Technology (MIT) shuttle, in cooperation with the Charles River Transportation Management Association, connects at Lechmere Station. This section lists and describes the various bus routes provided by the MBTA, including daily ridership as of February 2009. Service hours and headways for the MBTA routes are presented later in the section. Figure 5.5-1 shows the existing MBTA bus routes within the project study area.

#### MBTA Bus Services

##### No. 69: Harvard/Holyoke Gate – Lechmere Station via Cambridge Street

Route 69 is a local route that connects the Cambridge communities of Harvard Square, Inman Square, Wellington-Harrington, and east Cambridge. The route termini are the MBTA Red Line Harvard and Green Line Lechmere stations. The route travels Cambridge Street between the termini, serving a mixed-use commercial corridor, medical and educational institutions, and the Cambridge Public Library. This route is on the southern periphery of the project study area. In addition to its Lechmere Station connection, the route also operates within a short walk of the proposed Union Square Station. Average weekday daily ridership on this route is 2,985 boardings.

##### No. 80: Arlington Center – Lechmere Station via Powder House Square

Route 80 is a local route that follows a similar corridor to the Green Line Extension Medford Branch. Most of the route is within the project study area. The northwestern end of the route connects Arlington Center (in the Town of Arlington), Medford’s West Medford and Medford Hillside neighborhoods, and Tufts University. The route continues through Powder House Square, Ball Square and Magoun Square, and Gilman Square. The route terminates at Lechmere Station in Cambridge. The route would directly connect with the proposed Green Line Extension at College Avenue, Ball Square, Gilman Square, and relocated Lechmere Station. The route also travels near the proposed Washington Street station. Route 80 also travels near the MBTA West Medford Commuter Rail Station, providing a potential connection between this station and the Green Line Extension. The route follows Boston Avenue, College Avenue, Broadway, Medford Street, Pearl Street, McGrath Highway in Somerville, and Monsignor O’Brien Highway in Cambridge. Average weekday daily ridership on this route is 1,872 boardings.

### No. 85: Spring Hill – Kendall/MIT Station

Route 85 is a local route connecting the Somerville neighborhoods of Spring Hill and Union Square, Cambridge's Inman Square and Wellington-Harrington neighborhoods, Kendall Square, and the MBTA Red Line Kendall/MIT Station in Cambridge. Between Union Square and the Kendall Square terminus, the route shares the same corridor as the MBTA Cross Town #2 (CT2), which is described later in this section. Route 85 would provide a direct transfer at the proposed Union Square Station, and a connection between the proposed Union Square Branch and the MBTA Red Line. Average weekday daily ridership on this route is 397 boardings.

### No. 86: Sullivan Square Station – Cleveland Circle via Harvard Square

Route 86 is a cross-town route connects the MBTA Orange Line Sullivan Square Station (in Boston's Charlestown community) to Union Square and Harvard Square and the MBTA Red Line Harvard Station in Cambridge. It then continues south across the Charles River to the Boston communities of Allston and Brighton, and Brookline's Cleveland Circle neighborhood. Route 86 connects several existing and proposed MBTA rail transit services, including all existing and proposed branches of the MBTA Green Line, as well as the MBTA Red Line and MBTA Orange Line. The bus travels along Washington Street through the project study area between Sullivan Square and Union Square, with stops near the proposed Washington Street and Union Square Stations. Average weekday daily ridership on this route is 5,139 boardings.

### No. 87: Arlington Center/ Clarendon Hill – Lechmere via Davis Square and Union Square

Route 87 connects Arlington Center, Somerville's Clarendon Hill, Teele Square, Davis Square, and Union Square neighborhoods, and Lechmere Station in Cambridge. The corridor follows Broadway, Elm Street, and Somerville Avenue. The route operates near the proposed Union Square Station and provides an existing connection between the MBTA Green Line and MBTA Red Line. The route also travels near the MBTA Porter Square Station which, in addition to the MBTA Red Line, is served by the MBTA Fitchburg Line commuter rail. Average weekday daily ridership on this route is 3,373 boardings.

### No. 88: Clarendon Hill – Lechmere Station via Highland Avenue

Route 88 travels through the heart of Somerville, connecting Clarendon Hill, Teele Square, Davis Square, and Somerville City Center. The route terminates at Lechmere Station in Cambridge. The route currently connects the MBTA Green Line and MBTA Red Line, and travels near the proposed Green Line Extension stations at Lowell Street, Gilman Square, and Washington Street. The route follows Broadway, Holland Street, and Highland Avenue. The route's average weekday daily ridership is 3,785 boardings.

### No. 89: Clarendon Hill or Davis Square – Sullivan Square Station via Broadway

Route 89 operates with two service branches. The route operates along Broadway between the MBTA Orange Line Sullivan Square Station and Powder House Square in Somerville. This corridor connects to the proposed Ball Square Station and also serves Magoun Square (on the Medford/Somerville boundary) and Somerville's Winter Hill neighborhood. The branches continue from Powder House Square either to Davis Square/MBTA Red Line Davis Station or Clarendon Hill. Average weekday daily ridership on Route 89 is 3,431 boardings.

### No. 90: Davis Square – Wellington Station via Sullivan Square Station & Assembly Mall

Route 90 provides service between Davis Square and the MBTA Red Line Davis Square Station in Somerville and the MBTA Orange Line Wellington Station in Medford. The route shares a corridor with Route 88 along Highland Avenue, Somerville's "Main Street," between Davis and Gilman Squares. Between Gilman Square and Wellington Station, the route follows a zig-zag path with a connection to the MBTA Orange Line Sullivan Square Station. The route travels near the proposed Lowell Street and Gilman Square Green Line Extension stations. Average weekday daily ridership on this route is 920 boardings.

### No. 91: Sullivan Square Station – Central Square Cambridge via Washington Street

Route 91 is a local route between the MBTA Orange Line Sullivan Square Station (in Boston's Charlestown) and Central Square and the MBTA Red Line Central Square Station in Cambridge. The route travels through Union and Inman Squares, and would directly connect with the proposed Union Square Station. Average weekday daily ridership on this route is 1,482 boardings.

### No. 94: Medford Square – Davis Square Station via West Medford & Medford Hillside

Route 89 connects Medford Square, Medford's main commercial district, to Davis Square and the MBTA Red Line Davis Square Station in Somerville. Mid-route connections include the MBTA Lowell Line West Medford Commuter Rail Station, Medford Hillside, Tufts University, and Somerville's Powder House Square. This route travels through the project study area along Boston Street and College Avenue and would connect with the proposed College Avenue Station. Average weekday daily ridership on this route is 1,174 boardings.

### No. 95: West Medford – Sullivan Square Station via Mystic Avenue

Route 95 operates on the periphery of the project study area. The route travels between West Medford and the MBTA Orange Line Sullivan Square Station via

Medford Square. It connects with the MBTA Lowell Line West Medford Commuter Rail Station, where it also meets Route 94. Between Medford and Sullivan Squares, Route 95 follows Mystic Avenue, adjacent to I-93. The route does not intersect with any proposed Green Line Extension stations. Average weekday daily ridership on this route is 1,751 boardings.

### No. 96: Medford Square – Harvard Station via George Street & Davis Square Station

Route 96 operates between Medford Square and Cambridge's Harvard Square. The route provides a relatively direct connection between Medford Square and Tufts University, and would provide a connection to the proposed College Avenue Station. The route also connects to Powder House Square, Davis Square and the MBTA Red Line Davis Square Station, and the MBTA Red Line Porter and Fitchburg Line Commuter Rail Station. Thus, the route would connect the proposed Green Line Extension to both the Red Line and commuter rail. Average weekday daily ridership on this route is 1,500 boardings.

### No. 101: Malden Station – Sullivan Square Station via Salem Street, Main Street, & Broadway

Route 101 connects Malden Center and the MBTA Orange Line Malden Center and MBTA Haverhill Line Commuter Rail Station to Sullivan Square Station. Mid-route connections include Medford Square, the South Medford commercial area, and Somerville's Winter Hill. The route travels within five blocks of the proposed Ball Square Station. While the route does not connect directly with a proposed Green Line Extension station, three bus routes would provide transfers to the Green Line. Route 101 travels along Main Street and Broadway in the project study area. Average weekday daily ridership on this route is 4,116 boardings.

### No. 134: North Woburn - Wellington Station via Woburn, Winchester, Winthrop Street, Medford Square, Riverside Avenue, & Meadow Glen Mall

Route 134 is a suburban bus route travelling between the town of Woburn and the MBTA Orange Line Wellington Station in Medford. The route provides service to the town of Winchester and connects to both the MBTA Lowell Line commuter rail (at Winchester Center) and Medford Square. In the project study area, the route travels through West Medford along Winthrop Street. This route would not provide direct connections to the proposed Green Line Extension. Route 134 passengers could transfer to other bus routes at Medford Square to access the proposed College Avenue Station. Average weekday daily ridership on this route is 2,074 boardings.

### No. CT2: Sullivan Square Station - Ruggles Station via Kendall/MIT Station

Route CT2 is a limited stop, cross-town route that operates between the MBTA Orange Line Sullivan Square Station and the MBTA Orange Line Ruggles and Commuter Rail Station in central Boston. The route would intersect with the proposed Washington Street and Union Square Stations. The route connects with the MBTA Red Line Kendall/MIT Station. It also connects with the central MIT campus, as well as Boston University, the Longwood Medical Area, and all four Green Line branches south of the Charles River. This route follows Washington and Webster Streets in the project study area. Average weekday daily ridership on this route is 1,636 boardings.

## Shuttle Services

Tufts University operates student shuttle services. One of its routes travels between three stops on campus and Davis Square and the MBTA Red Line Davis Square Station. The route departs Davis Square every 15 minutes between 7:15 AM and 5:35 PM. The route offers night time service every 20 minutes until midnight Monday through Wednesday and 1:50 AM on Thursdays and Fridays. The route also provides extensive weekend service.[9]

In east Cambridge, the EZRide shuttle/MIT Northwest Shuttle connects Lechmere Station with the MIT campus, MBTA Red Line Kendall/MIT Station, CambridgeSide Galleria, the Museum of Science, and the MBTA North Station (Commuter Rail, Green, and Orange Lines) in Boston. The public cash fare is $1.00. The connection to Lechmere Station is available on weekday mornings and evenings. During these times, the shuttle operates every 10 minutes. The morning operation runs between approximately 6:25 AM and 10:25 AM. The evening operation runs between approximately 3:00 PM and 7:45 PM.[10]

## MBTA Bus Accessibility

The MBTA has a *Service Delivery Policy* that establishes the service objectives and standards for the MBTA system to “ensure that the MBTA provides quality transit services that meet the needs of the riding public.” The MBTA’s *Preliminary 2008 Service Plan: Bus, Rapid Transit, and Boat Service Changes and Service Delivery Plan Modification* includes an evaluation of route performance against the *Service Delivery Policy* standards.

A portion of the *Service Delivery Policy* identifies Service Objectives and Standards used to evaluate the MBTA’s service performance. One of the evaluation criteria is accessibility. The Span of Service Standard for hours during which service is accessible is shown in Table 5.5-1. The Minimum Frequency of Service Standard is shown in Table 5.5-2.

9 Tufts University Website. http://publicsafety.tufts.edu/adminsvc/?pid=6. Viewed on September 9, 2010.
10 Charles River Transportation Management Association EZRide Shuttle Website. Available at: http://www.charlesrivertma.org/program_ezride.htm. Viewed on September 9, 2010.

### Table 5.5-1 Span of Service Standards

| | Time | Minimum Span of Service |
|---|---|---|
| Bus (local) | Weekday | 7:00AM – 6:30PM |
| | Guideline for high density areas: | |
| | Saturday | 8:00 AM – 6:30 PM |
| | Sunday | 10:00 AM – 6:30 PM |
| Bus (community routes) | Weekday | 10:00 AM – 4:00 PM |
| Bus (express/community routes) | Weekday | 7:00 AM – 6:30 PM |
| | | (no service required 9:00 AM – 4:00 PM) |
| Bus (key community routes) | Weekday | 6:00 AM – midnight |
| | Saturday | 6:00 AM – midnight |
| | Sunday | 7:00 AM – midnight |

Source: MBTA. *Service Delivery Policy*, June 2, 2010.

### Table 5.5-2 Minimum Frequency of Service Standards

| Mode | Time | Minimum Frequency |
|---|---|---|
| Bus (local/community) | AM & PM Peak | 30-minute headway |
| | All Other Periods | 60-minute headway (Mid-day policy objective of 30-minute headway in high density areas) |
| | Saturday & Sunday –all day | 60-minute headway |
| Bus (express/commuter) | AM Peak | 3 trips in the peak direction |
| | PM Peak | 3 trips in the peak direction |
| Bus (key routes) | AM & PM Peak | 10-minute headway |
| | Early AM & Midday Base/School | 15-minute headway |
| | Evening & Late Eve | 20-minute headway |
| | Saturday –all day | 20-minute headway |
| | Sunday – all day | 20-minute headway |

Source: MBTA. *Service Delivery Policy*, June 2, 2010.

Bus service frequencies and daily ridership on the project study area bus routes are shown in Table 5.5-3. The MBTA's *Final 2008 Service Plan* contains a Summary Analysis of Routes and Proposed Changes that notes which routes meet or fail to meet each of the above listed standards in the *Service Delivery Policy*. Of all the bus services that are included in the project study area, only MBTA Routes 85, 90 and 94 do not meet the Minimum Frequency of Service Standard, while all routes meet the Span of Service Standard.

### Table 5.5-3 Bus Service Frequency and Ridership

| | | | Number of Weekday Inbound Bus Trips | | | | |
|---|---|---|---|---|---|---|---|
| Route | Daily Ridership | Ridership Rank | 5 AM - 9:30 AM | 9:30 AM - 4 PM | 4 PM - 7 PM | After 7 PM | Total |
| No. 69 | 2,985 | | 16 | 20 | 9 | 12 | 57 |
| No. 80 | 1,872 | | 13 | 13 | 8 | 6 | 40 |
| No. 85 | 397 | | 7 | 9 | 5 | 1 | 22 |
| No. 86 | 5,139 | 1 | 19 | 20 | 10 | 7 | 56 |
| No. 87 | 3,373 | 5 | 14 | 15 | 11 | 11 | 51 |
| No. 88 | 3,785 | 3 | 24 | 16 | 9 | 12 | 53 |
| No. 89 | 3,431 | 4 | 24 | 19 | 18 | 8 | 70 |
| No. 90 | 920 | | 6 | 9 | 5 | 3 | 23 |
| No. 91 | 1,482 | | 12 | 14 | 6 | 6 | 38 |
| No. 94 | 1,174 | | 11 | 9 | 8 | 7 | 35 |
| No. 95 | 1,751 | | 13 | 17 | 9 | 7 | 46 |
| No. 96 | 1,500 | | 12 | 9 | 9 | 8 | 38 |
| No. 101 | 4,116 | 2 | 26 | 22 | 12 | 6 | 66 |
| No. 134 | 2,074 | | 12 | 17 | 7 | 7 | 43 |
| No. CT2 | 1,636 | | 9 | 14 | 8 | 0 | 31 |
| **TOTAL** | **35,635** | | **211** | **223** | **137** | **98** | **669** |

Source: MBTA. *Ridership and Service Statistics* (Blue Book, Twelfth Edition), 2009 and MBTA Bus Schedule (August 2008).

## Bus Safety and Comfort

The MBTA's Service Standard for Safety and Comfort is identified in the *Service Delivery Policy* and is based on vehicle loading. The MBTA's Bus Loading Standards for bus service are shown in Table 5.5-4. These standards are calculated using an average maximum vehicle load per trip over any 30-minute peak-use period and 60-minute off-peak period.

### Table 5.5-4 MBTA Bus Loading Standards

| Time Period | Passengers/Seat |
|---|---|
| Early AM, AM Peak, Midday School & PM Peak | 140% |
| Midday Base, Evening, Late Evening, Night/Sunrise &Weekends | |
| Surface portions of routes | 100% |
| Tunnel portions of routes | 140% |

Source: MBTA. *Service Delivery Policy*, June 2, 2010.

Of all the bus services that are included in the project study area, Route 87 and Route 101 services do not meet the Bus Loading Standard and are overcrowded, according to the MBTA's *Preliminary 2008 Service Plan.*

## Bus Service Reliability

The portion of the *Service Delivery Policy* that deals with reliability includes Schedule Adherence Standards that are used to quantify the performance of each service and how well it adheres to the published schedules. The goal is to identify services that do not meet the standard, identify the problem and to take corrective action, where possible. The specific standards vary by the scheduled frequency of the route. Routes are divided into walk-up service where the service operates more frequently than every 10 minutes, and scheduled departure service, where headways are greater than 10 minutes. Passengers with high-frequency service are generally more interested in regular headways, whereas passengers on less frequent services expect departure as scheduled. Table 5.5-5 provides a summary of the MBTA's current Bus Schedule Adherence Standards.

According to the Summary Analysis of Routes and Recommended Changes in the MBTA's *Preliminary 2008 Service Plan*, all project study area bus routes except the Route 85 failed to meet the Schedule Adherence Standards for their weekday service from the *Service Delivery Policy*. Systemwide, only three percent of the MBTA's weekday bus routes met the Schedule Adherence Standard.

**Table 5.5-5 Summary of MBTA Bus Schedule Adherence Standards[1]**

| Trip Test | Beginning of Route | Mid-Route Time Point(s) | End of Route |
|---|---|---|---|
| Scheduled Departure Trips (Headways ≥10 min.) | Start 0 minutes early to 3 minutes late | Depart 0 minutes early to 7 minutes late | Arrive 3 minutes early to 5 minutes late |
| Walk-up Trips (Headways <10 min.) | Start within 1.5 times of scheduled headway | Leave within 1.5 times of scheduled headway | Running time within 20% of scheduled running time |

Source: MBTA. *Service Delivery Policy*, June 2, 2010.
1 For any given bus route to be in compliance with the Schedule Adherence standard, 75 percent of all time points must meet the criteria listed above.

## Bus Cost-Effectiveness

The *Service Delivery Policy* also contains the Cost-Effectiveness Service Standard to ensure that the operation of MBTA service is conducted within the resource levels budgeted for each mode. During the regular service planning process, all bus routes and their respective net cost per passenger is compared against the bus system average. Net cost per passenger is calculated by subtracting service revenue from the operating costs and dividing by number of boarding customers. Routes that have a net cost per passenger greater than or equal to three times the system average are considered deficient.

According to the Summary Analysis of Routes and Recommended Changes in the MBTA's *Preliminary 2008 Service Plan*, all project study area bus routes meet the Cost-Effective Service Standard.

## Bus System Improvements

New technologies and system improvements have been implemented in the MBTA bus system to provide high-quality and reliable transit service where it is most needed as demonstrated by various data collected as part of the MBTA's *Preliminary 2008 Service Plan* evaluations. Recent and ongoing improvement initiatives are listed below.

- Fleet Renewal:
  - As of 2009, about 86 percent of the fleet was vintage 2003 or newer;
  - 155 new buses were delivered in 2008;
  - The entire fleet is ADA accessible and operates with clean propulsion technologies; and
  - Low floor buses have replaced many of the MBTA's older high floor buses.
- Onboard technologies allow for enhanced service monitoring and bus intervention.
- Global Positioning Systems (GPS) has been incorporated into the majority of the bus fleet, which allows for onboard stop announcements and improved run time measurements. The run time measurements allow for more realistic schedules that reflect typical traffic conditions. Many schedules have been updated, particularly on routes with heavy ridership or reliability issues.
- Computer-Assisted Dispatch/Automated Vehicle Location (CAD/AVL) technology has been incorporated in the MBTA operations, allowing for enhanced real-time operational control. Customized strategies are being refined for each route to account for ridership patterns and roadway geometry.
- Automated Passenger Counters (APC) are available on some buses, enabling more frequent observations of ridership and crowding.
- Many of the MBTA's bus maintenance garages have reached their capacity. The MBTA has plans to expand existing facilities and/or construct garages to provide additional capacity. In the Green Line Extension project study area, all of the project study area bus routes are operated out of the MBTA's Charlestown Garage, with the exception of Routes 94 and 96 which operate out of the Fellsway Garage in Medford on weekdays and out of Charlestown on weekends (when the Fellsway facility is closed). The MBTA is planning for a new garage and maintenance facility for 250 buses, to be constructed at Medford's Wellington Station within the next few years.[11] This facility is intended to provide additional capacity and replace older garages, such as the Fellsway facility.

11 Massachusetts Bay Transportation Authority. *Final Strategic Plan for Bus Maintenance Facilities*, Prepared by Alternate Concepts/Stone & Webster, Joint Venture, April 2003. Available at: http://www.mbta.com/uploadedFiles/documents/Bus_Maint_Summar_Intro.pdf

## 5.5.2 Commuter Rail

This section discusses existing commuter rail service within the project study area including service headways and ridership. Figure 5.5-2 shows existing commuter rail routes through the project study area.

### MBTA Lowell Line

The MBTA Lowell Line (also known as the New Hampshire Mainline) extends northwest from Boston's North Station through Somerville and Medford to the City of Lowell. The route continues northwards into New Hampshire. The Boston – Portland intercity passenger rail service, operated by Amtrak as the "Downeaster," uses the segment of this route between Boston and Wilmington, Massachsuetts. From Boston through Lowell to the New Hampshire state line, the rail line is owned by the MBTA.

The 2009 *Vision for the New England High-Speed and Intercity Rail Network*[12] includes an extension of service from Lowell to the New Hampshire cities of Nashua, Manchester, and Concord. The State of New Hampshire, in cooperation with MassDOT, is proceeding with the initial design and operations planning to extend commuter rail service to Nashua. The route is also identified by the FTA as a future high-speed rail corridor between Boston and Montreal.

Freight service on the MBTA Lowell Line is operated by Pan Am Railways (formerly Guilford Rail System). The route is also used by a few trains operating on the MBTA Haverhill/Reading Line. Due to track capacity constraints, these trains are routed over the MBTA Lowell Line between North Station and Wilmington as non-stop trains.

Current MBTA Lowell Line commuter rail service consists of 31 inbound and 27 outbound weekday trains (including the MBTA Haverhill/Reading Line trains). Weekend and holiday service consists of eight inbound and eight outbound trains. In 2001, the MBTA opened a large intermodal station on the line in Woburn, the Anderson Regional Transportation Center, which provides parking and Logan Express Bus connections for passengers. At the northern end of the project study area, the West Medford Station is served by all of the scheduled commuter rail trains. Travel time from Lowell to Boston is approximately 50 minutes. Travel time between West Medford Station and Boston is approximately 12 minutes. West Medford Station generates approximately 603 daily inbound boardings.

In keeping with MBTA operating standards for its "North Side" commuter rail lines, all trains consist of single level commuter rail coaches operated in push–pull configuration with the locomotive typically at the outbound (or northern) end of the

12 Coalition of Northeastern Governors. *Vision for the New England High-Speed and Intercity Rail Network.* http://www.mass.gov/Agov3/docs/PR071309.pdf. July 13, 2009.

train. Maximum train lengths typically are six cars. Additional train capacity could be achieved in the near to mid-term by increasing train lengths to nine cars, subject to equipment availability. Long-term MBTA capital improvement plans call for the replacement of the single-level coaches with higher capacity bi-level coaches.

According to the MBTA's *Ridership and Service Statistics,*[13] average MBTA Lowell Line weekday ridership in 2008 was approximately 12,570 passenger boardings.
Table 5.5-6 shows weekday inbound boardings at each MBTA Lowell Line station in February 2008. Maximum train capacity, based on the use of six-car trains, is approximately 700 passengers.

**Table 5.5-6 MBTA Lowell Line Daily Weekday Boardings by Station**

| Station | Daily Weekday Inbound Boardings |
|---|---|
| Lowell | 1,398 |
| North Billerica | 1,043 |
| Wilmington | 638 |
| Anderson | 1,398 |
| Mishawum | 41 |
| Winchester Center | 746 |
| Wedgemere | 567 |
| West Medford | 603 |

Source: February 2008 Statistics, MBTA. *Ridership and Service Statistics* (Blue Book, Twelfth Edition), 2009.

## MBTA Fitchburg Line

The MBTA Fitchburg Line extends from North Station through Cambridge and Somerville, and then westward toward Fitchburg. Within the project study area, the route passes along the south side of the MBTA Boston Engine Terminal maintenance facility in Somerville. It continues west through Union Square, paralleling Somerville Avenue. The line shares a station at Porter Square in Cambridge with the MBTA Red Line. It then passes through North Cambridge and includes stations in the Town of Belmont, the City of Waltham, and several communities to the northwest. The Fitchburg terminus is approximately 50 track miles from North Station. Commuter rail service on this route consists of 17 inbound and 17 outbound trains on a weekday. Of these 17 trains, four inbound and outbound trains originate/terminate at South Acton, which is approximately halfway between Boston and Fitchburg. Travel time between Boston and Fitchburg is approximately 1 hour and 20 minutes. Travel time between Boston (North Station) and Porter Square is approximately 11 minutes.

13 Massachusetts Bay Transportation Authority. *Ridership and Service Statistics* (*Blue Book, Twelfth Edition*), 2009. Available at: http://www.mbta.com/uploadedfiles/documents/Bluebook%202009.pdf

In February 2004, the MBTA inaugurated express service on this route, with trains operating non-stop between South Acton and Porter Square. This operation reduced travel time by approximately 10 minutes between South Acton and Boston. Sunday and holiday service consists of seven inbound and outbound trips, with reduced frequencies between South Acton and Fitchburg. Eight inbound and outbound trips are operated on Saturdays.

According to the MBTA's *Ridership and Service Statistics*,[14] average weekday ridership on the MBTA Fitchburg Line in 2008 was approximately 9,900 boardings. Train capacity, based on a six-car train, is approximately 700 passengers. Table 5.5-7 shows February 2008 weekday inbound boardings at each MBTA Fitchburg Line station.

**Table 5.5-7 MBTA Fitchburg Line Daily Weekday Boardings by Station**

| | Daily Weekday Inbound Boardings |
|---|---|
| Fitchburg | 440 |
| North Leominster | 408 |
| Shirley | 218 |
| Ayer | 427 |
| Littleton/495 | 244 |
| South Acton | 885 |
| West Concord | 516 |
| Concord | 541 |
| Lincoln | 275 |
| Silver Hill | 15 |
| Hastings | 38 |
| Kendal Green | 165 |
| Brandeis/Roberts | 629 |
| Waltham | 556 |
| Waverley | 110 |
| Belmont | 154 |
| Porter | 206 |

Source: February 2008 Statistics, MBTA. *Ridership and Service Statistics* (Blue Book, Twelfth Edition), 2009.

14 Ibid.

### 5.5.3 Freight Rail

The Green Line Extension project is envisioned to be adjacent to existing operating rail lines. Freight rail operations in the project study area are provided by two railroads: CSX and Pan Am Railway (PAR).[15]

#### CSX Freight Operations

CSX is a major railway system operating in the eastern United States, with routes from Massachusetts to Florida, and New York to Illinois. In the Boston area, CSX operates an intermodal yard in the Allston neighborhood. Beacon Park Yard is the hub for CSX operations in eastern Massachusetts and the end of its Boston & Albany mainline. The Beacon Park intermodal activity is expected to be relocated from Boston to the vicinity of Worcester, Massachusetts.

CSX operations within the project study area are depicted in Figure 5.5-3. Through the project study area, CSX operates a daily round trip between Beacon Park Yard and Chelsea via its Grand Junction Branch. This line crosses the MBTA Fitchburg Line near the Monsignor O'Brien Highway overpass. From this point, the freight track parallels the MBTA Fitchburg Line a few hundred feet where it connects to the "Valley Tracks" just west of the MBTA Boston Engine Terminal maintenance facility. The Valley Tracks in turn connect to the Eastern Route Mainline (MBTA Newburyport/Rockport Line). CSX trains use the Eastern Route through Sullivan Square, over the Mystic River and into Everett. The CSX Grand Junction line has its own separate track through Everett and into Chelsea.

Figure 5.5-3 depicts the CSX freight routes from the Grand Junction branch to the Valley Tracks and onto the Eastern Route.

#### PAR Freight Operations

PAR is a Class 2 railroad with lines in northern New England, Massachusetts, and New York. All freight operations are performed by PAR's subsidiary Springfield Terminal Railway (ST).[16] Consolidated from the former B&M and Maine Central railroads, the current freight operations are generally oriented east-west, with most trains bypassing Boston.

PAR freight operations in the Boston area are limited to serving customers in the MBTA Boston Engine Terminal area, the last remnant of the former large railyards in Somerville, Cambridge, and Boston's Charlestown community. Other customers are

15 Pan Am Railway (PAR) is the corporate name for the railway previously known as Guilford Rail System.
16 Springfield Terminal (ST) Railway, owned by PAR, is the designated operating railroad for PAR. All train crews are employed by ST.

along the Eastern Route (MBTA Newburyport/Rockport Line through Chelsea, Lynn, Salem and Peabody) and occasionally in the Fresh Pond/West Cambridge area.

All PAR freight trains reach the MBTA Boston Engine Terminal area by the MBTA Lowell Line. Southbound freight trains typically take the southbound main track to the Walnut Street crossover onto the "third iron" or lead track to Yard 8. While the third iron extends north to CP-3 north of Lowell Street, the portion between CP-3 and Walnut Street is not currently used. After crossing over Washington Street, trains on the third iron would pass through Yard 8 and use the Wiley Track to reach the "Valley Tracks," which is the curved track on the west side of the MBTA Boston Engine Terminal maintenance facility.

From the Valley, the trains would either cross over to the Eastern Route and proceed northbound to Chelsea, Salem, and Peabody, or pull onto the third or fourth "iron." From the third or fourth iron, the train can either back into Boston Sand & Gravel or reverse direction to head west on the MBTA Fitchburg Line to North Cambridge. PAR freight routes in the MBTA Boston Engine Terminal area are depicted in Figure 5.5-3.

Once a major freight yard in the B&M Railroad operations, today the portion of Yard 8 owned by PAR includes one through track (connecting the MBTA Lowell Line to the Valley via the Wiley Track) and one side track. The MBTA owns the half of the yard adjacent to the Brickbottom district and PAR owns the half closer to Inner Belt. MassDOT is in the process of obtaining the PAR-owned portion of Yard 8.

All PAR movements arriving or departing via the MBTA Lowell Line pass through Yard 8. The side track is used for occasional storage of freight cars. It also serves as a run-around track, allowing the locomotives to be uncoupled from one end of the train and placed at the other end.

## 5.6 Traffic

The evaluation of existing traffic conditions throughout the project study area includes current traffic volumes, operations, safety and geometric conditions. The evaluation focused on morning and evening peak hour traffic volumes, recent crash history at project study area intersections, traffic operations, pedestrian operations, and bicycle circulation. A comprehensive parking inventory was performed to support a future conditions assessment of potential parking impacts associated with the Green Line Extension project.

## 5.6.1 Traffic Study Intersections

The project study area includes 47 intersections (Figure 5.6-1):

- Mystic Valley Parkway/Route 16 at:
  - Alewife Brook Parkway (unsignalized rotary)
  - Auburn Street (signalized)
  - Winthrop Street (signalized)
- Boston Avenue at:
  - High Street and Sagamore Avenue (flashing signal)
  - Mystic Valley Parkway/Route 16 (signalized)
  - North Street (signalized)
  - Winthrop Street and Curtis Street (signalized)
  - College Avenue (signalized)
  - Harvard Street and Warner Street (signalized)
- Broadway at:
  - Boston Avenue (signalized)
  - Winchester Street/Albion Street (unsignalized)
- College Avenue at:
  - Powder House Boulevard/Broadway/Warner Street (flashing signal/signalized mid-block pedestrian crossing; rotary)
  - George Street (unsignalized)
- Main Street at:
  - High Street/Salem Street/Forest Avenue/Riverside Avenue (signalized)
  - South Street and Mystic Valley Parkway/Route 16 Eastbound Ramps (flashing signal)
  - Mystic Valley Parkway/Route 16 Westbound Ramps (flashing signal)
  - Mystic Avenue (flashing signal)
  - Harvard Street (signalized)
  - George Street (flashing signal)
- Medford Street at:
  - Broadway and Dexter Street (signalized)
  - Lowell Street (unsignalized)
  - Central Street (signalized)
  - School Street (signalized)
  - Pearl Street (unsignalized)
  - Walnut Street (signalized)
  - Highland Avenue and Hamlet Street (signalized)
  - Somerville Avenue and McGrath Highway/Route 28 (signalized)
- Highland Avenue at:
  - Lowell Street (signalized)
  - Central Street (signalized)
  - School Street (signalized)

- Washington Street at:
  - Inner Belt Road (signalized)
  - Tufts Street (unsignalized)
  - Joy Street (unsignalized)
  - McGrath Highway/Route 28 (signalized)
  - Somerville Avenue and Webster Street (signalized)
  - Beacon Street and Kirkland Street (signalized)
- Prospect Street at:
  - Somerville Avenue and Washington Street (signalized)
  - Webster Avenue and Concord Avenue (signalized)
  - Cambridge Street (signalized)
  - Hampshire Street (signalized)
- Monsignor O'Brien Highway at:
  - Third Street (signalized)
  - Water Street (unsignalized)
  - North First Street (Build Condition only)
  - East Street (signalized)
  - Land Boulevard/Gilmore Bridge (signalized)
  - Museum Way (signalized)
- Cambridge Street at:
  - First Street (signalized)

The intersections chosen for study were included due to their proximity to proposed station locations or to address specific concerns raised by residents as part of the public involvement process.

### 5.6.2 Traffic Volumes

Daily and peak hour traffic volume data were collected to establish baseline traffic conditions within the project study area. How traffic fluctuates over a typical day provides insight into when peak periods occur and the intensity of traffic occurring during the peak period. Daily traffic volumes were obtained by Automatic Traffic Recorders throughout the project study area for a typical weekday. These data are summarized in Table 5.6-1.

Manual peak hour turning movement and vehicle classification counts were conducted at each of the project study area intersections from 7:00 to 10:00 AM and 3:00 to 6:00 PM on November 7 and 8, 2007, May 15, 2008, September 10, 2008, and October 30, 2008.

## Table 5.6-1 Existing Daily Traffic Volumes on Project Study Area Roadways

| | | | Weekday Morning Peak Hour | | | Weekday Evening Peak Hour | | |
|---|---|---|---|---|---|---|---|---|
| Location | Direction | Weekday ADT[1] | Volume (vph)[2] | "k" factor[3] | Directional Flow | Volume (vph) | "k" factor | Directional Flow |
| High Street East of Canal Street | Eastbound | 8,995 | 570 | 6.3% | 54% | 775 | 8.6% | 57% |
| | Westbound | 8,375 | 480 | 5.7% | 46% | 580 | 6.9% | 43% |
| | Total | 17,370 | 1,050 | 6.0% | 100% | 1,355 | 7.8% | 100% |
| Canal Street South of Prescott Street | Northbound | 1,670 | 185 | 11.1% | 50% | 180 | 10.8% | 60% |
| | Southbound | 1,455 | 185 | 12.7% | 50% | 120 | 8.2% | 40% |
| | Total | 3,125 | 370 | 11.8% | 100% | 300 | 9.6% | 100% |
| Mystic Valley Parkway West of Boston Avenue | Eastbound | 13,435 | 955 | 7.1% | 44% | 965 | 7.2% | 47% |
| | Westbound | 15,480 | 1,210 | 7.8% | 56% | 1,075 | 6.9% | 53% |
| | Total | 28,915 | 2,165 | 7.5% | 100% | 2,040 | 7.1% | 100% |
| Boston Avenue North of Holton Street | Northbound | 3,010 | 230 | 7.6% | 36% | 280 | 9.3% | 54% |
| | Southbound | 3,200 | 415 | 13.0% | 64% | 235 | 7.3% | 46% |
| | Total | 6,210 | 645 | 10.4% | 100% | 515 | 8.3% | 100% |
| Boston Avenue South of University Avenue | Northbound | 5,580 | 295 | 5.3% | 34% | 540 | 9.7% | 62% |
| | Southbound | 5,425 | 575 | 10.6% | 66% | 325 | 6.0% | 38% |
| | Total | 11,005 | 870 | 7.9% | 100% | 865 | 7.9% | 100% |
| Boston Avenue South of Harvard Street | Northbound | 3,105 | 225 | 7.2% | 39% | 290 | 9.3% | 55% |
| | Southbound | 3,210 | 350 | 10.9% | 61% | 240 | 7.5% | 45% |
| | Total | 6,315 | 575 | 9.1% | 100% | 530 | 8.4% | 100% |
| College Avenue East of Boston Avenue | Eastbound | 3,795 | 230 | 6.1% | 35% | 355 | 9.4% | 50% |
| | Westbound | 4,930 | 435 | 8.8% | 65% | 360 | 7.3% | 50% |
| | Total | 8,725 | 665 | 7.6% | 100% | 715 | 8.2% | 100% |
| College Avenue West of Boston Avenue | Eastbound | 4,030 | 215 | 5.3% | 28% | 370 | 9.2% | 50% |
| | Westbound | 5,400 | 550 | 10.2% | 72% | 375 | 6.9% | 50% |
| | Total | 9,430 | 765 | 8.1% | 100% | 745 | 7.9% | 100% |
| Winthrop Street East of Boston Avenue | Eastbound | 7,200 | 595 | 8.3% | 64% | 720 | 10.0% | 72% |
| | Westbound | 3,990 | 335 | 8.4% | 36% | 285 | 7.1% | 28% |
| | Total | 11,190 | 930 | 8.3% | 100% | 1,005 | 9.0% | 100% |
| Curtis Street West of Boston Avenue | Eastbound | 4,465 | 350 | 7.8% | 71% | 345 | 7.7% | 70% |
| | Westbound | 2,405 | 145 | 6.0% | 29% | 150 | 6.2% | 30% |
| | Total | 6,870 | 495 | 7.2% | 100% | 495 | 7.2% | 100% |
| Harvard Street East of Boston Avenue | Eastbound | 7,585 | 525 | 6.9% | 46% | 550 | 7.3% | 48% |
| | Westbound | 9,235 | 605 | 6.6% | 54% | 600 | 6.5% | 52% |
| | Total | 16,820 | 1,130 | 6.7% | 100% | 1,150 | 6.8% | 100% |
| Broadway Between Boston Avenue & Winchester Street | Eastbound | 11,205 | 1,030 | 9.2% | 57% | 745 | 6.6% | 45% |
| | Westbound | 10,450 | 785 | 7.5% | 43% | 920 | 8.8% | 55% |
| | Total | 21,655 | 1,815 | 8.4% | 100% | 1,665 | 7.7% | 100% |
| Broadway South of Powder House Square | Northbound | 8,150 | 585 | 7.2% | 42% | 645 | 7.9% | 51% |
| | Southbound | 8,590 | 805 | 9.4% | 58% | 610 | 7.1% | 49% |
| | Total | 16,740 | 1,390 | 8.3% | 100% | 1,255 | 7.5% | 100% |
| Willow Avenue Between Broadway & Kidder Avenue | Northbound | 2,730 | 165 | 6.0% | 54% | 240 | 8.8% | 70% |
| | Southbound | 1,710 | 195 | 11.4% | 46% | 105 | 6.1% | 30% |
| | Total | 4,440 | 360 | 8.1% | 100% | 345 | 7.8% | 100% |
| Medford Street South of School Street | Northbound | 4,405 | 190 | 4.3% | 27% | 425 | 9.6% | 63% |
| | Southbound | 4,525 | 520 | 11.5% | 73% | 245 | 5.4% | 37% |
| | Total | 8,930 | 710 | 8.0% | 100% | 670 | 7.5% | 100% |

## Table 5.6-1 Existing Daily Traffic Volumes on Project Study Area Roadways (continued)

| | | | Weekday Morning Peak Hour | | | Weekday Evening Peak Hour | | |
|---|---|---|---|---|---|---|---|---|
| Location | Direction | Weekday ADT[1] | Volume (vph)[2] | "k" factor[3] | Directional Flow | Volume (vph) | "k" factor | Directional Flow |
| Medford Street Between School Street & Central Street | Eastbound | 8,570 | 895 | 10.4% | 77% | 525 | 6.1% | 55% |
| | Westbound | 4,910 | 260 | 5.3% | 23% | 435 | 8.9% | 45% |
| | Total | 13,480 | 1,155 | 8.6% | 100% | 960 | 7.1% | 100% |
| Highland Avenue South of School Street | Northbound | 6,680 | 375 | 5.6% | 35% | 675 | 10.1% | 56% |
| | Southbound | 9,435 | 700 | 7.4% | 65% | 530 | 5.6% | 44% |
| | Total | 16,115 | 1,075 | 6.7% | 100% | 1,205 | 7.5% | 100% |
| School Street Between Medford Street & Highland Avenue | Southbound | 5,540 | 490 | 8.8% | 100% | 440 | 7.9% | 100% |
| Lowell Street Between Vernon Street & Princeton Street | Northbound | 1,785 | 115 | 6.4% | 34% | 140 | 7.8% | 54% |
| | Southbound | 1,740 | 225 | 12.9% | 66% | 120 | 6.9% | 46% |
| | Total | 3,525 | 340 | 9.6% | 100% | 260 | 7.4% | 100% |
| McGrath Highway/Route 28 Between Greenville Street and Cross Street | Northbound | 22,345 | 975 | 4.4% | 24% | 2,115 | 9.5% | 56% |
| | Southbound | 29,105 | 3,045 | 10.5% | 76% | 1,650 | 5.7% | 44% |
| | Total | 51,450 | 4,020 | 7.8% | 100% | 3,765 | 7.3% | 100% |
| Washington Street West of Hawkins Street | Eastbound | 4,980 | 355 | 7.1% | 52% | 375 | 7.5% | 54% |
| | Westbound | 5,205 | 330 | 6.3% | 48% | 325 | 6.2% | 46% |
| | Total | 10,185 | 685 | 6.7% | 100% | 700 | 6.9% | 100% |
| Washington Street East of Tufts Avenue | Eastbound | 10,050 | 540 | 5.4% | 35% | 765 | 7.6% | 44% |
| | Westbound | 14,460 | 995 | 6.9% | 65% | 960 | 6.6% | 56% |
| | Total | 24,510 | 1,535 | 6.3% | 100% | 1,725 | 7.0% | 100% |
| Washington Street East of Merriam Street | Eastbound | 12,865 | 730 | 5.7% | 41% | 975 | 7.6% | 51% |
| | Westbound | 13,940 | 1,040 | 7.5% | 59% | 940 | 6.7% | 49% |
| | Total | 26,805 | 1,770 | 6.6% | 100% | 1,915 | 7.1% | 100% |
| Somerville Avenue East of Prospect Street | Eastbound | 7,005 | 480 | 6.9% | 72% | 465 | 6.6% | 61% |
| | Westbound | 4,030 | 185 | 4.6% | 28% | 300 | 7.4% | 39% |
| | Total | 11,035 | 665 | 6.0% | 100% | 765 | 6.9% | 100% |
| Prospect Street South of Webster Street | Northbound | 6,410 | 315 | 4.9% | 53% | 430 | 6.7% | 64% |
| | Southbound | 3,920 | 285 | 7.3% | 47% | 240 | 6.1% | 36% |
| | Total | 10,330 | 600 | 5.8% | 100% | 670 | 6.5% | 100% |
| Webster Street South of Prospect Street | Northbound | 5,180 | 230 | 4.4% | 37% | 485 | 9.3% | 76% |
| | Southbound | 3,645 | 385 | 10.6% | 63% | 155 | 4.3% | 24% |
| | Total | 8,825 | 615 | 7.0% | 100% | 640 | 7.3% | 100% |

Source: 24-hour Automatic Traffic Recorder counts conducted by Precision Data Industries, LLC in November 2007.
1 Daily traffic expressed in vehicles per day.
2 Peak hour volumes expressed in vehicles per hour.
3 Percent of daily traffic that occurs during the peak hour.

### 5.6.3 Intersection Geometrics and Traffic Control

The majority (32 of 45) of the project study area intersections are controlled by traffic signals. Traffic signal timing and phasing were obtained from the traffic signal controllers at each signalized intersection in January 2008. These data were supplemented by more recent data at traffic signal locations that have been modified since 2008 (such as intersections along Monsignor O'Brien Highway in Cambridge).

### 5.6.4 Intersection Safety

A safety assessment was conducted for project study area intersections using MassDOT crash records for 2006 through 2008 (the most recent three years for which data are currently available). These data include all reported crashes at project study area intersections with a property damage value greater than $1,000 or crashes that involved personal injuries or fatalities. A complete analysis is provided in Appendix D, *Transportation Analysis*.

Twenty-four project study area intersections experienced, on average, five or fewer crashes per year. Eight locations experienced an average greater than 10 crashes per year:

- Mystic Valley Parkway/Route 16 at Winthrop Avenue
- Powder House Square rotary
- High Street/Riverside at Main Street/Forest Street
- Main Street at Mystic Valley Parkway
- Main Street at Harvard Street
- Medford Street at Somerville Avenue
- Washington Street at McGrath Highway/Route 28
- Monsignor O'Brien Highway at Land Boulevard/Gilmore Bridge

The high crash rates are likely a result of the heavy traffic volume these intersections process during the peak periods. Long vehicle delays and queuing combined with heavy turning movements may create a situation of red-light running or vehicles attempting to turn after the traffic signal has turned red.

As part of the safety assessment, crash rates were calculated for all project study area intersections. A crash rate is the representative number of crashes that occur at a particular intersection for every 1,000,000 vehicles that enter that intersection. For example, a crash rate of 1.0 indicates that one crash occurs at an intersection for every 1,000,000 vehicles that enter it. The calculated crash rates were then measured against the current statewide average crash rates (0.82 for signalized intersections and 0.62 for unsignalized intersections) and MassDOT District 4 average crash rates (0.78 for signalized intersections and 0.59 for unsignalized intersections) to determine whether intersections in the project study area experience greater than average crash occurrences. Table 5.6-2 provides the fifteen intersections that exceed either the statewide or District 4 average rates.

**Table 5.6-2 Intersections Exceeding Statewide or District 4 Average Rates**

| Intersection | Crash Rate |
|---|---|
| Mystic Valley Parkway at Winthrop Street | 1.09 |
| Boston Avenue at North Street | 0.79 |
| High Street/Riverside at Forest Street/Main Street | 1.17 |
| Main Street at Mystic Valley Parkway | 1.63 |
| Main Street at Mystic Avenue | 0.86 |
| Main Street at Harvard Street | 1.14 |
| Main Street at George Street | 0.88 |
| Broadway Street at Medford Street/Dexter Street | 0.97 |
| Medford Street at Lowell Street | 0.93 |
| Highland Avenue at Central Street | 0.86 |
| Washington Street at McGrath Highway | 1.26 |
| Washington Street at Beacon Street | 1.12 |
| Prospect Street at Cambridge Street | 1.38 |
| Prospect Street at Hampshire Street | 1.01 |
| Medford Street at Pearl Street | 0.69 |

The safety assessment also included a review of the statewide High Crash Location list.[17] This annually published list includes the top 200 crash locations within the Commonwealth. Three of the 47 project study area intersections appear on the list. While crash rates only consider the number of crashes and traffic volume at an intersection, the High Crash Location list also includes the severity of the accident and whether any fatalities or personal injuries occur. Therefore, it is possible to have a High Crash Location that does not exceed the statewide average crash rate. The three intersections on the current High Crash Location list are:

- Mystic Valley Parkway/Route 16 at Winthrop Street (ranked 112)
- Salem Street at High Street (ranked 160)
- Prospect Street at Cambridge Street (ranked 185)

It should be noted that the 2008 High Crash Location list is based on crash statistics from 2006 to 2008. Any safety modifications to the intersections made since 2008 are not reflected in the rankings available.

### 5.6.5 Traffic Operations Analysis

Intersection capacity analyses were conducted for the project study area intersections based on the existing traffic volumes, intersection geometry, and traffic control. Capacity analyses provide an indication of how well the intersections accommodate

17 Massachusetts Department of Transportation, Highway Division. *2008 Top Crash Locations Report*, March 2010. Available at: http://www.mhd.state.ma.us/downloads/trafficMgmt/08TopCrashLocationsRpt.pdf

the traffic demands placed upon them. Two computer software packages, SYNCHRO (intersection analysis) and Sidra Intersection (roundabout analysis), were used to model traffic conditions at the project study area intersections. These two software packages are based on procedures outlined in the *2000 Highway Capacity Manual*.[18]

LOS is the term used to denote the different operating conditions that occur at a given intersection under various traffic conditions. It is a qualitative measure of the effect of a number of factors including roadway geometrics, speed, travel delay, freedom to maneuver, and safety. LOS provides an index to the operational qualities of an intersection. LOS designations range from A to F, with LOS A representing the optimal operating conditions with little or no delay and LOS F representing the worst operating conditions with high congestion and long delays. LOS D or better is generally considered an acceptable operating condition. Thresholds for vehicular LOS are shown in Table 5.6-3.

### Table 5.6-3 Vehicular Level of Service Thresholds

| | Average Delay (seconds) | |
|---|---|---|
| Level of Service | Signalized Intersection | Unsignalized Intersection |
| A | <10 | <10 |
| B | > 10 to 20 | > 10 to 15 |
| C | > 20 to 35 | > 15 to 25 |
| D | > 35 to 55 | > 25 to 35 |
| E | > 55 to 80 | > 35 to 50 |
| F | > 80 | > 50 |

Source: Transportation Research Board. *2000 Highway Capacity Manual, Special Report 209*, Washington, D.C., 2000.

LOS designation is reported differently for signalized and unsignalized intersections. For signalized intersections, the analysis considers the operation of each lane group entering the intersection and the LOS designation represents overall conditions at the intersection. For unsignalized intersections, the analysis assumes that traffic on the mainline is not affected by traffic on the minor side streets. The LOS is determined separately for left-turns from the main street and all movements from the minor street. The unsignalized intersection LOS presented is for the most critical movement, often the left-turns out of the side street. The results of the existing conditions traffic operations analysis are presented in Tables 5.6-4 and 5.6-5.

18 Transportation Research Board. *2000 Highway Capacity Manual, Special Report 209*, Washington, D.C., 2000.

## Table 5.6-4 Existing Signalized Intersection Traffic Operations

| Intersection | Morning Peak Hour V/C[1] | Delay[2] | LOS[3] | Evening Peak Hour V/C | Delay | LOS |
|---|---|---|---|---|---|---|
| Mystic Valley Pkwy at Boston Avenue | 0.93 | 61 | E | 1.06 | 82 | F |
| Mystic Valley Pkwy at Auburn Street (East) | 0.81 | 33 | C | 0.79 | 35 | D |
| Mystic Valley Pkwy at Auburn (West) | 0.68 | 11 | B | 0.64 | 26 | C |
| Mystic Valley Pkwy at Winthrop Street | > 1.20 | >120 | F | > 1.20 | >120 | F |
| Boston Avenue at North Street | 0.52 | 17 | B | 0.39 | 16 | B |
| Boston Avenue at Winthrop Street | 1.00 | 46 | D | 0.99 | 55 | D |
| Boston Avenue at College Avenue | 0.92 | 55 | D | 0.86 | 47 | D |
| Boston Avenue at Harvard Street/Warner Street | 0.74 | 20 | B | 0.74 | 19 | B |
| Broadway at Boston Avenue (Ball Square) | 0.81 | 30 | C | 0.64 | 12 | B |
| College Avenue at Powder House Blvd/Broadway/Warner Street (East Side) | 0.52 | 2 | A | 0.60 | 2 | A |
| College Avenue at Powder House Blvd/Broadway/Warner Street (West Side) | 0.70 | 4 | A | 0.58 | 2 | A |
| Main Street at High Street/Salem Street/Forest Avenue/Riverside Avenue | 0.95 | 57 | E | 0.74 | 32 | C |
| Main Street at Clipper Ship Drive | 0.61 | 1 | A | 0.52 | 4 | A |
| Main Street at Harvard Street | 1.09 | 79 | E | 1.12 | 80 | E |
| Broadway at Medford Street/Dexter Street | 0.96 | 68 | E | 0.85 | 47 | D |
| Medford Street at Central Street | 0.71 | 20 | C | 0.64 | 20 | C |
| Medford Street at School Street | 0.87 | 26 | C | 0.83 | 29 | C |
| Medford Street at Walnut Street | 0.51 | 17 | B | 0.51 | 16 | B |
| Medford Street at Highland Avenue | 0.88 | 41 | D | 0.60 | 14 | B |
| Medford Street at Somerville Avenue/McGrath Hwy | 0.70 | 34 | C | 0.65 | 33 | C |
| Highland Avenue at Lowell Street | 0.64 | 17 | B | 0.50 | 12 | B |
| Highland Avenue at Central Street | 0.62 | 16 | B | 0.68 | 17 | B |
| Highland Avenue at School Street | 0.79 | 30 | C | 0.75 | 25 | C |
| Washington Street at McGrath Hwy (East) | 0.54 | 27 | C | 0.74 | 117 | F |
| Washington Street at McGrath Hwy (West) | 0.66 | 200 | F | 0.57 | 103 | F |
| Washington Street at Inner Belt Road | 0.63 | 9 | A | 0.72 | 14 | B |
| Prospect Street at Somerville Avenue | 0.89 | 67 | E | 0.94 | 65 | E |
| Washington Street at Somerville Avenue/Webster Street | 0.85 | 38 | D | 0.79 | 38 | D |
| Washington Street at Beacon Street/Kirkland Street | 0.84 | 32 | C | 0.80 | 27 | C |
| Prospect Street at Webster Street/Concord Avenue | 0.71 | 30 | C | 1.19 | 136 | F |
| Prospect Street at Cambridge Street | 0.59 | 22 | C | 0.79 | 29 | C |
| Prospect Street at Hampshire Street | 0.64 | 27 | C | 0.56 | 25 | C |
| Monsignor O'Brien Highway/Route 28 at Land Boulevard/Gilmore Bridge | 1.17 | >120 | F | 1.16 | >120 | F |
| Monsignor O'Brien Highway/Route 28 at Third Street | 0.69 | 18 | B | 0.95 | >120 | F |
| Monsignor O'Brien Highway at Museum Way | 0.72 | 11 | B | 0.60 | 11 | B |
| Cambridge Street at First Street | 0.48 | 16 | B | 0.48 | 18 | B |

Source: Vanasse Hangen Brustlin, Inc. using Synchro 6 (Build 614) software.
1 Volume-to-capacity ratio
2 Average delay expressed in seconds per vehicle
3 Level-of-Service

As shown in Table 5.6-4, 11 signalized intersections currently operate at an unacceptable LOS E or LOS F during one or both peak hours:

- Mystic Valley Parkway/Route 16 at Boston Avenue
- Mystic Valley Parkway/Route 16 at Winthrop Street
- Main Street at High Street/Salem Street/Forest Avenue/Riverside Avenue
- Main Street at Harvard Street
- Broadway at Medford Street/Dexter Street
- Washington Street at McGrath Highway/Route 28 (east and west)
- Prospect Street at Somerville Avenue
- Prospect Street at Webster Street and Concord Avenue
- Monsignor O'Brien Highway/Route 28 at Land Boulevard and Gilmore Bridge (also known as Charlestown Avenue)
- Monsignor O'Brien Highway/Route 28 and Third Street
- As shown in Table 5.6-5, 10 unsignalized intersections currently operate at an unacceptable LOS E or LOS F during one or both peak hours:
- Boston Avenue at High Street and Sagamore Avenue
- Main Street at George Street
- Main Street at Mystic Avenue and the Fire Station Driveway
- Main Street at South Street and Mystic Valley Parkway/Route 16 eastbound ramps
- Main Street at Mystic Valley Parkway/Route 16 westbound ramps
- Medford Street at Lowell Street
- Medford Street at Pearl Street
- Broadway at Winchester Street/Albion Street
- Washington Street at Joy Street
- Washington Street at Tufts Street/Knowlton Street

The observed traffic volumes at the majority of existing unsignalized intersections far exceed the physical capacity of the intersections; leading to lengthy delays and, in some cases, long vehicle queues.

**Table 5.6-5 Existing Unsignalized Intersection Traffic Operations**

| Intersection | Critical Movement | Morning Peak Hour | | | Evening Peak Hour | | |
|---|---|---|---|---|---|---|---|
| | | V/C[1] | Delay[2] | LOS[3] | V/C[1] | Delay | LOS |
| Boston Avenue at High Street/ Sagamore Avenue | High Street Northbound | >1.2 | >120 | F | >1.2 | >120 | F |
| College Avenue at George Street | George Street Westbound | 0.74 | 17 | C | 0.82 | 21 | C |
| Main Street at George Street | George Street Eastbound | >1.2 | >120 | F | >1.2 | >120 | F |
| Main Street at Mystic Avenue/ Fire Station Driveway | Main Street Eastbound | >1.2 | >120 | F | >1.2 | >120 | F |
| Main Street at South Street/Mystic Valley Pkwy Eastbound Ramps | South Street Eastbound | >1.2 | >120 | F | >1.2 | >120 | F |
| Main Street at Mystic Valley Pkwy Westbound Ramps | Mystic Valley Pkwy Westbound Ramps | >1.2 | >120 | F | >1.2 | >120 | F |
| Medford Street at Lowell Street | Lowell Street Northbound | 1.02 | >120 | F | 0.32 | 18 | C |
| Medford Street at Pearl Street | Pearl Street Westbound | 0.96 | 74 | F | 0.70 | 26 | D |
| Broadway at Winchester Street/ Albion Street | Winchester/Albion Southbound | >1.2 | >120 | F | 0.79 | 87 | F |
| Washington Street at Joy Street | Joy Street | 0.48 | 91 | F | >1.2 | >120 | F |
| Washington Street at Tufts Street/Knowlton Street | Tufts Street | >1.2 | >120 | F | >1.2 | >120 | F |
| Monsignor O'Brien Highway at Water Street | Water Street | 0.03 | 9 | A | 0.02 | 11 | B |
| **Roundabout** | | | | | | | |
| Mystic Valley Pkwy at Alewife Brook Pkwy | – | 1.02 | 34 | C | 1.13 | 43 | D |

Source: VHB, Inc. Using Synchro 6 (Build 614) and Sidra Intersection 4.0 software.
1 Volume-to-capacity ratio
2 Average delay expressed in seconds per vehicle
3 Level-of-Service

## 5.6.6 Pedestrian Operations

Crosswalk analyses were conducted at all project study area intersections. Pedestrian Level of Service (PLOS) provides an index to quantify pedestrian delay similar to that of vehicles. PLOS A represents excellent pedestrian operations and PLOS F represents an unacceptable delay for pedestrians waiting to cross the roadway. Thresholds for PLOS are noted in Table 5.6-6.

Pedestrian delay was calculated using the *2000 Highway Capacity Manual Equation 18-5* for signalized intersections. At signalized intersections, the PLOS is not a function of the capacity of the crossing but a function of the green time allotted for pedestrians to cross. According to the *2000 Highway Capacity Manual*, pedestrians experiencing more than a 30-second delay become impatient and more likely to engage in "risk taking" behavior. As shown in Table 5.6-5, as pedestrian delay increases, so does the likelihood of noncompliance when conflicting vehicle volumes are low to moderate. However, at intersections with high conflicting vehicle volumes, pedestrians have no choice but to wait for the walk signal so their disregard of the signal indication is reduced.

### Table 5.6-6 Pedestrian Level of Service Thresholds

| Pedestrian Level of Service | Average Delay per Pedestrian (seconds) | |
|---|---|---|
| | Signalized Intersection | Likelihood of Compliance |
| A | <10 | Very High |
| B | > 10 to 20 | High |
| C | > 20 to 30 | High |
| D | > 30 to 40 | Low |
| E | > 40 to 60 | Moderate |
| F | > 60 | High |

Source: Transportation Research Board. *2000 Highway Capacity Manual, Special Report 209*, Washington, D.C., 2000. Assumes low to moderate conflicting vehicle volumes.

The crossing time at each crosswalk was calculated based on the length of the individual crosswalks and a 3.5-foot per second walking speed. In conformance with signal design guidelines, this crossing time represents the flashing "Don't Walk" phase of the traffic signal cycle. For locations with concurrent pedestrian phasing, the flashing "Don't Walk" time (minus four seconds per the *2000 Highway Capacity Manual*) was subtracted from the total red-time for the approach, deriving an effective walk (green time) for pedestrians. Where an exclusive pedestrian phase is provided, it forms the basis for the PLOS analysis.

Table 5.6-7 presents the pedestrian crossing analysis. Pedestrian crossings at 17 project study area intersections operate at PLOS E or PLOS F during at least one peak hour. This poor PLOS is the result of the long traffic signal cycle lengths needed to process vehicular traffic and a relatively short pedestrian crossing phase. In addition to crossing delays, 18 signalized intersections were found to have substandard Walk/Flashing "Don't Walk" phases under the existing condition. Pedestrian volumes at all project study area intersections are provided in Appendix D, *Transportation Analysis*.

## Table 5.6-7 Existing Pedestrian Level of Service

| | | Morning Peak Hour | | Evening Peak Hour | |
|---|---|---|---|---|---|
| Intersection | Crosswalk | Average Delay (sec) | PLOS | Average Delay (sec) | PLOS |
| Mystic Valley Pkwy at Auburn Street | North | 60 | E | 60 | E |
| | South | 56 | F | 56 | F |
| Mystic Valley Pkwy at Winthrop Street | North | 68 | F | 68 | F |
| | South | 64 | F | 64 | F |
| | East | 60 | E | 60 | E |
| | West | 65 | F | 65 | F |
| Mystic Valley Pkwy at Boston Avenue | North | 54 | E | 54 | E |
| | South | 54 | E | 54 | E |
| | East | 54 | E | 54 | E |
| | West | 55 | E | 55 | E |
| Boston Avenue at North Street | North | 40 | D | 40 | D |
| | South | 39 | D | 39 | D |
| | East | 37 | D | 37 | D |
| | West | 36 | D | 36 | D |
| Boston Avenue at Winthrop Street | North | 37 | D | 37 | D |
| | South | 35 | D | 35 | D |
| | East | 35 | D | 35 | D |
| | West | 32 | D | 32 | D |
| Boston Avenue at College Avenue | North | 59 | E | 59 | E |
| | South | 59 | E | 59 | E |
| | East | 55 | E | 55 | E |
| | West | 56 | E | 56 | E |
| Boston Avenue at Harvard Street/Warner Street | North | 52 | E | 42 | E |
| | South | 52 | E | 42 | E |
| | East | 55 | E | 45 | E |
| | West | 55 | E | 45 | E |
| College Avenue at Powder House Blvd/Broadway/Warner Street (East Side) | North | 30 | C | 30 | C |
| | South | 27 | C | 27 | C |
| | West | 32 | D | 32 | D |
| College Avenue at Powder House Blvd/Broadway/Warner Street (West Side) | North | 34 | D | 34 | D |
| | West | 36 | D | 36 | D |
| Main Street at High Street/Salem Street/Forest Avenue/Riverside Avenue | North | 9 | A | 9 | A |
| | South | 43 | E | 43 | E |
| | Northeast | 34 | D | 34 | D |
| | East | 27 | C | 27 | C |
| | West | 37 | D | 31 | D |
| Main Street at Harvard Street | North | 38 | D | 38 | D |
| | South | 35 | D | 35 | D |
| | East | 35 | D | 35 | D |
| | West | 35 | D | 35 | D |
| Broadway at Medford Street | North | 58 | E | 58 | E |
| | South | 53 | E | 53 | E |
| | Northwest | 60 | F | 60 | F |
| | Southeast | 58 | E | 58 | E |
| | East | 49 | E | 49 | E |
| | West | 51 | E | 51 | E |

## Table 5.6-7 Existing Pedestrian Level of Service (continued)

| Intersection | Crosswalk | Morning Peak Hour Average Delay (sec) | Morning Peak Hour PLOS | Evening Peak Hour Average Delay (sec) | Evening Peak Hour PLOS |
|---|---|---|---|---|---|
| Medford Street at Central Street | North | 35 | D | 35 | D |
| | South | 34 | D | 34 | D |
| | East | 33 | D | 33 | D |
| | West | 39 | D | 39 | D |
| Medford Street at School Street | North | 28 | C | 28 | C |
| | South | 28 | C | 28 | C |
| | East | 28 | C | 28 | C |
| | West | 28 | C | 28 | C |
| Medford Street at Walnut Street | North | 32 | D | 32 | D |
| | South | 32 | D | 32 | D |
| | East | 31 | D | 31 | D |
| | West | 31 | D | 31 | D |
| Medford Street at Highland Avenue | North | 28 | C | 28 | C |
| | South | 25 | C | 25 | C |
| | East | 31 | D | 31 | D |
| | West | 29 | C | 29 | C |
| Medford Street at Somerville Avenue/McGrath Hwy | North | 48 | E | 48 | E |
| | South | 53 | E | 53 | E |
| | West | 33 | D | 33 | D |
| Highland Avenue at Lowell Street | North | 28 | C | 28 | C |
| | South | 28 | C | 28 | C |
| | East | 31 | D | 31 | D |
| | West | 31 | D | 31 | D |
| Highland Avenue at Central Street | North | 35 | D | 35 | D |
| | South | 35 | D | 35 | D |
| | East | 37 | D | 37 | D |
| | West | 37 | D | 37 | D |
| Highland Avenue at School Street | North | 39 | D | 39 | D |
| | South | 37 | D | 37 | D |
| | East | 40 | E | 40 | E |
| | West | 40 | E | 40 | E |
| Washington Street at Inner Belt Road | South | 34 | D | 34 | D |
| | West | 36 | D | 36 | D |
| Washington Street at McGrath Highway/ Route 28 (East) | North | 20 | B | 20 | B |
| Washington Street at McGrath Highway/ Route 28 (West) | North | 3 | A | 3 | A |
| Washington Street at Somerville Avenue/Webster Street | North | 51 | E | 50 | E |
| | South | 41 | E | 40 | E |
| | East | 54 | E | 53 | E |
| | West | 50 | E | 49 | E |
| | North | 41 | E | 41 | E |

**Table 5.6-7 Existing Pedestrian Level of Service (continued)**

| | | Morning Peak Hour | | Evening Peak Hour | |
|---|---|---|---|---|---|
| Intersection | Crosswalk | Average Delay (sec) | PLOS | Average Delay (sec) | PLOS |
| Washington Street at Beacon Street/Kirkland Street | South | 41 | E | 41 | E |
| | East | 40 | D | 40 | D |
| | West | 39 | D | 39 | D |
| | North | 50 | E | 51 | E |
| Prospect Street at Somerville Avenue | South | 43 | E | 44 | E |
| | East | 47 | E | 48 | E |
| | West | 51 | E | 52 | E |
| Prospect Street at Webster Street | North | 33 | D | 33 | D |
| | South | 42 | E | 42 | E |
| | Southwest | 32 | D | 32 | D |
| | West | 31 | D | 31 | D |
| Prospect Street at Cambridge Street | North | 21 | C | 22 | C |
| | South | 21 | C | 22 | C |
| | East | 20 | B | 19 | B |
| | West | 20 | B | 19 | B |
| Prospect Street at Hampshire Street | North | 14 | B | 16 | B |
| | South | 15 | B | 17 | B |
| | East | 26 | C | 23 | C |
| | West | 25 | C | 22 | C |
| Monsignor O'Brien Highway at Third Street | South | 58 | E | 58 | E |
| | East | 50 | E | 50 | E |
| Monsignor O'Brien Highway at Land Boulevard/Gilmore Bridge | South | 44 | E | 53 | E |
| | East | 69 | F | 58 | E |
| | West | 26 | C | 43 | E |
| Monsignor O'Brien Highway at Museum Way | North | 17 | B | 17 | B |
| | East | 54 | E | 54 | E |
| | West | 37 | D | 37 | D |
| Cambridge Street at First Street | South | 43 | E | 43 | E |
| | East | 41 | E | 41 | E |
| | West | 37 | D | 37 | D |

## Pedestrian Safety

As part of the safety assessment discussed in Section 5.6.4, *Intersection Safety*, the MassDOT Crash database was reviewed for any crashes specific to pedestrians. In the three-year period between January 2006 and December 2008, 13 crashes involving pedestrians were reported at project study area intersections; three each in Medford and Cambridge, and seven in Somerville. No fatalities were reported; however, eight of the crashes involved personal injury. Four crashes occurred during the daytime in clear weather conditions. The remaining crashes occurred in poor weather conditions and/or at night. Four of the intersections experienced more than one pedestrian injury over the three-year period:

- Cambridge Street at Prospect Street (2 crashes)
- Highland Avenue at Central Street (3 crashes)
- Washington Street at Beacon Street (2 crashes)
- Main Street at Harvard Street (3 crashes)

It is important to note that the MassDOT database has been created to provide information on vehicular crashes in cities and towns throughout Massachusetts. Therefore, the pedestrian incidents are all a result of vehicular conflict. Pedestrian incidents resulting from a conflict with a bicycle or other non-motorized source are not included. No database quantifying these types of incidents currently exists.

### 5.6.7 Bicycles

The project study area for the Green Line Extension project consists of relatively dense urban and suburban land uses. These communities typically have a larger than average number of bicyclists due to the proximity of Cambridge, Somerville, and Medford to each other and Boston, a high student population, and relatively low access to automobiles per capita. The current terminus of the Green Line is at the convergence of the planned Minuteman Commuter Bikeway/Somerville Community Path, planned NorthPoint bike system, the Dr. Paul Dudley White Bicycle Path, and the DCR Charles River Basin park system.

Bicycle turning movements were observed at each of the project study area intersections during the morning and evening weekday peak hours. Bicycle volumes are moderate (less than 30 bicycles were noted on most roadways during the peak hour) throughout the project study area. The largest bicycle volumes were observed along Somerville Avenue, McGrath and Monsignor O'Brien Highways, and Washington Street. A higher concentration of bicycles was also seen in the vicinity of Powder House Square and Union Square. Minimal bicycle traffic was observed along Mystic Valley Parkway/Route 16 and Boston Avenue, where narrower roadway cross-sections and higher vehicle speeds may make cycling an unpleasant option for users. Bicycle volume observations can be found in Appendix D, *Transportation Analysis*.

Bicycle parking is somewhat limited throughout the project study area. There were a number of observations of bicycles locked to sign posts, parking meters, and fences. No bicycle parking areas were noted in the immediate vicinity of the proposed station locations. At the time of the data collection effort, a single City of Cambridge post/ring bicycle stand was noted at Lechmere Station.

As part of the safety assessment discussed in Section 5.6.4, *Intersection Safety*, the MassDOT Crash database was reviewed for any crashes specific to bicycles. In the three-year period between January 2006 and December 2008, 28 crashes involving bicycles were reported at project study area intersections; 15 in Somerville, four in Cambridge, and nine in Medford. No fatalities were reported. However, 22 of the bicycle crashes involved personal injury. Only two cases reported wet roadway conditions. Eight incidents occurred at night. Two or more bicycle incidents per location (over the three-year period) were reported at or near six intersections:

- Powder House Square rotary (4 crashes)
- Monsignor O'Brien at Land Boulevard (2 crashes)
- Somerville Street at Prospect Street (3 crashes)
- Medford Street at Somerville Street (2 crashes)
- Boston Street at Winthrop Street (2 crashes)
- Main Street at Mystic Valley Parkway (2 crashes)

The remainder of incidents occurred at various locations throughout the project study area.

It is important to note that the MassDOT database has been created to provide information on vehicular crashes in cities and towns throughout Massachusetts. Therefore, these bicycle incidents are all a result of vehicular conflict. Bicycle incidents resulting from a conflict with another bicycle, pedestrian, or fixed object are not included. No database quantifying these types of incidents currently exists.

### 5.6.8 Parking

A limited parking inventory was conducted in the immediate vicinity of each of the proposed stations. This inventory includes on-street parking regulations, total parking supply, and the mid-day parking utilization (the number of parking spaces occupied) within 500 feet of the proposed station platforms. Public off-street parking facilities were also included in the inventory. There is currently a lack of parking policy in the City of Medford and some areas in the City of Somerville. As Green Line Extension design advances, an evaluation of existing parking regulations and current parking use in the vicinity of the proposed station areas would help determine the loss of parking spaces expected during construction or use by future Green Line Extension riders. Table 5.6-8 summarizes the findings of the parking inventory.

**Table 5.6-8 Parking Inventory**

| | Total Parking Supply (number of spaces) | | | | Percent Occupied[1] | | | |
|---|---|---|---|---|---|---|---|---|
| Station | Unrestricted | Restricted[2] | Permit Only | Metered | Unrestricted | Restricted | Permit Only | Metered |
| College Avenue | 63 | 4 | 172 | 0 | 79% | 0% | 25% | 0% |
| Ball Square | 153 | 17 | 105 | 42 | 49% | 12% | 42% | 48% |
| Lowell Street | 97 | 5 | 75 | 0 | 44% | 20% | 33% | 0% |
| Gilman Square | 127 | 20 | 22 | 0 | 57% | 53% | 82% | 0% |
| Washington Street | 62 | 18 | 25 | 0 | 68% | 10% | 72% | 0% |
| Union Square | 49 | 6 | 35 | 0 | 61% | 0% | 69% | 0% |
| Lechmere | 41 | 375 | 15 | 0 | 98% | 95% | 60% | 0% |

1 The percentage of parking spaces that were observed to be full during the middle of a typical weekday.
2 Restricted spaces include handicapped spaces, loading zones, areas with parking time limits, and MBTA dedicated spaces at Lechmere Station.

A majority of parking spaces in the vicinity of Tufts University are regulated by parking permit for use by faculty, staff, and students. A number of additional spaces are restricted by length of stay. Restricted spaces include handicapped spaces, loading zones, areas with parking time limits, and MBTA dedicated spaces at Lechmere Station. Time restrictions are enforced either by pay meter (all metered parking has a maximum time limit of two hours) or City parking enforcement. A breakdown of the restricted parking spaces near each proposed station is provided in Table 5.6-9. Parking at Lechmere Station is restricted to MBTA patrons.

**Table 5.6-9 Restricted Parking Allocation**

| | Number of Restricted Spaces By Type | | | | |
|---|---|---|---|---|---|
| Station | Handicapped | Loading Zone | 15-minute | 2-hour | MBTA |
| College Avenue | 3 | 1 | 0 | 0 | 0 |
| Ball Square | 5 | 6 | 6 | 0 | 0 |
| Lowell Street | 5 | 0 | 0 | 0 | 0 |
| Gilman Square | 0 | 0 | 0 | 20 | 0 |
| Washington Street | 0 | 0 | 0 | 18 | 0 |
| Union Square | 0 | 1 | 0 | 5 | 0 |
| Lechmere[1] | 0 | 0 | 0 | 0 | 375 |

1 Lechmere Station parking count as of May 2008

### 5.6.9 Summary

The assessment of traffic within the project study area evaluated existing traffic and pedestrian operations, and safety statistics at 47 intersections throughout the communities of Cambridge, Somerville, and Medford. Parking and bicycle accommodations throughout the project study area were observed in the vicinity of the proposed station locations and along key project study area roadways.

The existing conditions assessment shows that:

- Fifteen project study area intersections currently exceed either the statewide or District 4 average crash rate;
- Three project study area intersections are currently ranked on the MassDOT Top 1,000 High Crash Location list;
- Eleven signalized intersections and 10 unsignalized intersections currently operate at unacceptable levels of service during at least one peak hour;
- Pedestrians currently experience a high pedestrian delay (greater than 40 seconds) at 17 signalized intersections;
- While bicyclists were observed on almost all project study area roadways, parking and/or storage areas for bicycles are minimal; and
- A limited supply of unrestricted parking is available to the public, with the majority of these spaces observed to be full during the midday period.

## 5.7 Air Quality

The FTA, in cooperation with the FHWA, has established procedures for Transportation Conformity requirements of the Clean Air Act Amendments of 1990 (CAAA). The Transportation Conformity provisions are intended to integrate transportation and air quality planning in areas that are designated by the EPA as not meeting the NAAQS.

Transit projects are an important part of improving air quality. The air quality study includes a local and regional air quality analysis that demonstrates compliance with the SIP and Transportation Conformity provisions. The local (microscale) analysis evaluated CO and particulate matter (PM), including PM less than 10 microns aerodynamic diameter ($PM_{10}$) and less than 2.5 microns aerodynamic diameter ($PM_{2.5}$). The regional (mesoscale) analysis evaluated ozone precursors (VOCs, oxides of nitrogen [$NO_X$], and the greenhouse gas carbon dioxide [$CO_2$]), in addition to CO and PM.

Guidance from both the EPA and MassDEP define the air quality modeling and review criteria for analyses prepared pursuant to the CAAA and SIP. The CAAA and the SIP require that a proposed project not:

- Cause any new violation of the NAAQS;
- Increase the frequency or severity of any existing violations; or
- Delay attainment of any NAAQS.

The CAAA resulted in states being divided into attainment and non-attainment areas with classifications based upon the severity of air quality pollution. A non-attainment area is an area that has had measured pollutant levels that exceed the NAAQS and that has not been designated to attainment. The CAAA established emission reduction requirements that vary by an area's classification. The attainment status of each pollutant in the project study area is discussed below.

***Carbon Monoxide (CO) Status.*** The Cities of Somerville and Medford are in attainment for CO; however, the City of Cambridge is classified as a Maintenance attainment area for CO. Proposed projects that are in CO non-attainment or Maintenance attainment areas are required to evaluate their impact on CO concentrations and the NAAQS.

***Particulate Matter (PM) Status.*** The Cities of Cambridge, Somerville, and Medford are in attainment for PM.

***Ozone Status***. Massachusetts has been determined to be a non-attainment area, statewide, for ozone. The State has been divided into two non-attainment areas, Eastern and Western Massachusetts. On June 15, 2005, the EPA revoked the 1-hour ozone standard for most areas in the country. The project is in the Eastern Massachusetts 8-hour ozone non-attainment area, which has been classified as "Moderate."

***Greenhouse Gas Status.*** EEA has issued a policy and protocol for evaluating greenhouse gas (GHG) emissions from proposed projects with particular emphasis on $CO_2$ emissions. This policy requires that certain projects quantify greenhouse gas emissions generated by the project and identify measures to reduce or minimize these impacts.

### 5.7.1 Air Quality Modeling Methodology

The air quality study evaluated the 2007 existing conditions for local and regional emissions against which future emissions could be compared. The 2007 conditions included the existing traffic conditions in the project study area, and accounted for the existing roadway geometrics and observations of traffic flow. The general modeling process to determine whether the project would have air quality impacts utilized travel data from the most recent CTPS statewide traffic model available and emission factors derived using the EPA's MOBILE6.2 emission factor model.[19]

The microscale analysis calculated CO and PM concentrations for congested intersections in the project study area. The mesoscale analysis calculated VOCs, $NO_X$, PM, CO, and $CO_2$ emissions for the existing conditions within the project study area. The mesoscale analysis developed traffic (volumes and speeds) and emission factor data for the 2007 conditions. These data were incorporated into air quality models. The 2007 conditions represent current traffic conditions in the project study area. Appendix E, *Air Quality Analysis*, provides the results of the air quality analysis.

## Microscale Analysis Methodology

The microscale analysis evaluated the CO and PM concentrations at congested intersections in the project study area. The intersections selected for microscale air quality modeling were selected based upon the procedures outlined by the EPA and as referenced in the MassDEP guidelines.[20] These procedures require that the intersection be ranked by their LOS and their total traffic volumes and that the air quality analysis model the highest three intersections in each ranking. Study intersections that would be impacted by station-related traffic and represent those that are in the vicinity of the proposed station sites were added. Intersections in the project study area were ranked based on traffic volumes and LOS. The following intersections (Figure 5.7-1) were selected for analysis because they were the most congested intersections in the project study area:

- Mystic Valley Parkway/Route 16 at Boston Avenue
- Mystic Valley Parkway/Route 16 at Winthrop Street
- Mystic Valley Parkway/Route 16 Eastbound at Main Street and South Street
- Boston Avenue at College Avenue
- Harvard Street at Main Street
- Medford Street at Broadway and Dexter Street
- Highland Street at Central Street
- School Street at Medford Street
- Somerville Avenue at Webster Avenue
- Washington Street at McGrath Highway/Route 28 (East)

19 The air quality analysis uses the traffic volumes and operations (as outlined in the traffic section) which is based on the updated CTPS statewide traffic model, August 2010. In addition, the MOBILE emission factors were updated to the latest available information in October 2010.

20 United States Environmental Protection Agency. *Guidelines for Modeling Carbon Monoxide from Roadway Intersections*, Office of Air Quality Planning and Standards, Technical Support Division; Research Triangle Park, NC; EPA-454/R-92-005; November 1992. Available at: http://nepis.epa.gov/Exe/ZyPURL.cgi?Dockey=2000F7L2.txt

- Monsignor O'Brien Highway/Route 28 at Third Street
- Monsignor O'Brien Highway/Route 28 at East Street
- Cambridge Street at First Street
- Monsignor O'Brien Highway/Route 28/Charles River Dam Bridge at Charlestown Avenue/Commercial Avenue

The microscale analysis calculated maximum 1-hour and 8-hour CO concentrations and the 24-hour PM concentrations in the project study area. The EPA model CAL3QHC[21] was used to predict CO and PM concentrations at receptor locations for each intersection. These receptor locations were selected since they are where the public has access and is expected to be for periods of time. Receptors were placed at the edge of the roadway, but not closer than 10 feet (3 meters) from the nearest travel lane, so that they were not within the roadway mixing cell. The results calculated at these receptor locations represent the highest concentrations at each intersection. Receptor locations farther away from the intersections would have lower concentrations because of the CO and PM dispersion characteristics. The receptor locations that are along the major roadways in the project study area are also expected to have lower CO and PM concentrations than intersection receptors. The emission rates for vehicles traveling along these roadways are much lower than the emission rates for vehicles queuing at intersections.

The 1-hour CO concentrations were calculated directly using the EPA CAL3QHC model, with evening peak hour traffic and emission data. The 8-hour CO concentrations were derived by applying a persistence factor of 0.68 to the 1-hour CO concentrations. This persistence factor was calculated from the MassDEP's most recent annual monitoring report.[22] It represents the average ratio of second highest 8-hour to second highest 1-hour CO readings at MassDEP's four Boston-area permanent monitoring stations.

The 24-hour $PM_{10}$ concentrations are expressed in micrograms per cubic meter ($\mu g/m^3$) and include a 24-hour background concentration of 45.7 $\mu g/m^3$, which was based on MassDEP air quality monitoring data.

The 1-hour $PM_{2.5}$ concentrations were calculated using EPA's CAL3QHC model and were then adjusted using MassDEP standards to develop the 24-hour and annual $PM_{2.5}$ concentrations. The $PM_{2.5}$ concentrations are also expressed in $\mu g/m^3$ and include a 24-hour background concentration of 29.7 $\mu g/m^3$ and an annual background concentration of 11.7 $\mu g/m^3$ which was based on MassDEP air quality monitoring data.

21 United States Environmental Protection Agency. *User's Guide to CAL3QHC Version 2.0: Modeling Methodology for Predicting Pollutant Concentrations Near Roadway Intersections*, EPA-454/R-92-006; November 1992.

22 United States Environmental Protection Agency, Region I. *2000 Annual Report on Air Quality in New England,* July 2001. Available at: http://www.epa.gov/region01/oeme/AnnualReport2006.pdf

## Mesoscale Analysis Methodology

The predominant sources of regional pollution impacts anticipated from the Green Line Extension project are emissions reductions resulting from modal travel shifts from private automobiles to rail service. The mesoscale analysis uses traffic and emissions data for existing and future (No-Build and Proposed Action) conditions. The general modeling process to determine whether the Green Line Extension project would have air quality impacts utilized link-by-link travel data from the CTPS statewide traffic model and emission factors derived using the EPA's MOBILE6.2 emission factor model. The link-by-link traffic data includes daily vehicle volumes as well as free flow and congested speeds over each link. The vehicle volumes are combined with the link lengths in order to determine the daily VMT over the link. The VMT is then multiplied by the appropriate speed-specific emission factors in order to arrive at the total daily emissions for each link.

The roadways included in the mesoscale project study area include the roadways coded in the CTPS statewide model and generally include Eastern Massachusetts. The mesoscale analysis estimated the future regional VOCs, $NO_x$, PM, CO, and $CO_2$, emissions due to the changes in average daily traffic volume, roadway characteristics, and vehicle emissions. The mesoscale analysis traffic (volumes, delays, and speeds) and emission factor data were developed for these conditions.

The objective of the mesoscale analysis was to estimate the change in area-wide emissions of ozone precursor (VOCs, $NO_x$, PM, and CO) emissions during a typical day and $CO_2$ emissions during the entire year resulting from implementing the proposed Green Line Extension. The daily area-wide emissions are presented in kilograms per day (kg/day) to be consistent with the SIP emission inventories and in terms of tons per year to be consistent with Massachusetts GHG policy.

The vehicle emission factors used in the microscale and mesoscale analysis were obtained using the EPA's MOBILE6.2[23] emissions model. MOBILE6.2 calculates emission factors from motor vehicles in grams per vehicle-mile for existing and future conditions. The emission rates calculated in this air quality study are adjusted to reflect Massachusetts-specific conditions such as the vehicle age distribution, the statewide Inspection and Maintenance (I/M) Program, and the Stage II Vapor Recovery System.[24] VOC and $NO_X$ emission factors for the mesoscale analysis were determined using the MassDEP-recommended temperatures for the summer (ozone) season and similarly for the microscale analysis, the CO emission factors were determined using winter (CO) seasons.

23 United States Environmental Protection Agency. *MOBILE 6.2 (Mobile Source Emission Factor Model)*, May 2004. Available at: http://www.epa.gov/oms/m6.htm

24 The Stage II Vapor Recovery System is the process of collecting gasoline vapors from vehicles as they are refueled. This requires the use of a special gasoline nozzle at the fuel pump.

The air quality study used traffic data (volumes, delays, and speeds) developed for each analysis condition. The microscale analysis used the evening peak hour traffic conditions during the CO season (winter). The mesoscale analysis for VOC and $NO_x$ emissions used typical daily peak and off-peak traffic volumes for the ozone season (summer). Vehicle speeds are developed based upon traffic volumes, observed traffic flow characteristics, and roadway capacity. The detailed traffic analysis is presented in Section 5.6, *Traffic*.

### 5.7.2 Microscale Analysis Results

All the 1-hour and 8-hour existing CO concentrations are below the CO NAAQS of 35 and 9 parts per million (ppm), respectively. These values are consistent with the area's designation as a Maintenance CO attainment area. The results of the microscale analysis for existing conditions are presented in Table 5.7-1. The microscale analysis determined that the 1-hour CO concentrations for 2007 ranged from 4.5 ppm to 8.3 ppm. The minimum 4.5 ppm value occurred at the intersections of Highland at Central Street and the maximum at the intersection of Monsignor O'Brien Highway at Charlestown Avenue and Land Boulevard. The corresponding maximum 8-hour CO concentrations for 2007 ranged from a minimum of 3.0 ppm to a maximum of 5.6 ppm.

The 24-hour $PM_{10}$ concentrations are below the PM NAAQS of 150 ppm. These values are consistent with the area's designation as a PM attainment area. The microscale analysis determined that the 24-hour $PM_{10}$ concentrations for 2007 ranged from 48 ppm to 51 ppm. The minimum 48 ppm value occurred at three intersections; Boston at College Avenue, Highland at Central Street, and School Street at Medford Street. The maximum 51 ppm value occurred at the intersections of the Monsignor O'Brien Highway at Charlestown Avenue and Land Boulevard.

The existing 24-hour $PM_{2.5}$ concentrations ranged from a minimum of 30.9 $\mu g/m^3$ to a maximum of 33.3 $\mu g/m^3$. All of the existing 24-hour $PM_{2.5}$ concentrations are below the $PM_{2.5}$ NAAQS of 35$\mu g/m^3$. The annual $PM_{2.5}$ concentrations for existing conditions ranged from a minimum of 11.9$\mu g/m^3$ to a maximum of 12.4$\mu g/m^3$. All of the annual $PM_{2.5}$ concentrations are well below the $PM_{2.5}$ NAAQS of 15 $\mu g/m^3$.

**Table 5.7-1 Estimated Maximum Air Pollutant Concentrations in 2007[1]**

| Intersection Number and Intersection[2] | | 1-Hour CO (ppm)[3] | 8-Hour CO (ppm)[4] | 24-Hour $PM_{10}$ (µg/m³)[5] | 24-Hour $PM_{2.5}$ (µg/m³)[6] | 24-Hour $PM_{2.5}$ (µg/m³)[7] |
|---|---|---|---|---|---|---|
| 1 | Mystic Valley Parkway at Boston Avenue | 5.5 | 3.7 | 49 | 31.7 | 12.1 |
| 2 | Mystic Valley Parkway at Winthrop Street | 6.6 | 4.5 | 51 | 32.9 | 12.3 |
| 3 | Mystic Valley Parkway Eastbound off-ramp at Main Street and South Street | 4.9 | 3.3 | 49 | 31.7 | 12.1 |
| 4 | Boston Avenue at College Avenue | 5.3 | 3.6 | 48 | 31.3 | 12.0 |
| 5 | Harvard Street at Main Street | 4.8 | 3.3 | 49 | 31.3 | 12.0 |
| 6 | Medford Street at Broadwayand Dexter Street | 5.6 | 3.8 | 49 | 31.7 | 12.1 |
| 7 | Highland Street at Central Street | 4.5 | 3.0 | 48 | 30.9 | 11.9 |
| 8 | School Street at Medford Street | 4.6 | 3.1 | 48 | 31.3 | 12.0 |
| 9 | Somerville Avenue at Washington and Prospect Street | 6.4 | 4.4 | 50 | 32.5 | 12.3 |
| 10 | Washington Street at McGrath Highway | 5.8 | 3.9 | 49 | 32.1 | 12.2 |
| 11 | Monsignor O'Brien Highway at Third Street | 6.0 | 4.1 | 49 | 32.1 | 12.2 |
| 12 | Monsignor O'Brien Highway at East Street/ Cambridge Street | 5.7 | 3.9 | 49 | 31.7 | 12.1 |
| 13 | Cambridge Street at First Street | 4.8 | 3.2 | 49 | 31.3 | 12.0 |
| 14 | Monsignor O'Brien Highway at Charlestown Avenue/Land Boulevard | 8.3 | 5.6 | 51 | 33.3 | 12.4 |

Source: Vanasse Hangen Brustlin, Inc. 2010.

1 The emissions presented represent the highest emissions experienced at each intersection. The remaining emissions at the intersections are included in Appendix E, *Air Quality Analysis*. The air quality study assumes that if these intersections meet the NAAQS, then all other intersections would have lower volumes and better levels of service, can be assumed to also meet the NAAQS.
2 These intersections are depicted on Figure 5.7-1.
3 The concentrations are expressed in ppm and include a 1-hour background concentration of 3.0 ppm. The 1-hour NAAQS for CO is 35 ppm.
4 The concentrations are expressed in ppm and a persistence factor of 0.68 was used. The 8-hour NAAQS for CO is 9 ppm.
5 The concentrations are expressed in µg/m³. The background concentrations assumed for the 24-Hour $PM_{10}$ was 45.7 µg/m³. The NAAQS for $PM_{10}$ is 150 µg/m³.
6 The concentrations are expressed in µg/m³. The background concentrations assumed for the 24-Hour $PM_{2.5}$ was 29.7 µg/m³. The NAAQS for $PM_{2.5}$ is 35 µg/m³.
7 The background concentrations assumed for the annual $PM_{2.5}$ was 11.7 µg/m³.

### 5.7.3 Mesoscale Analysis Results

Under existing conditions, VOC emissions are estimated to be 55,825 kg/day and the $NO_x$ emissions are estimated to be 161,463 kg/day. The PM emissions are estimated to be 4,578 kg/day for $PM_{10}$ and 2,892 kg/day for $PM_{2.5}$. The CO (winter) emissions are estimated to be 1,465,221 kg/day and the $CO_2$ emissions are estimated to be 58,128,707 kg/day.

## 5.8 Noise

This section describes the existing noise conditions along the proposed Green Line Extension project study corridor including:

- Background information on airborne noise and ground-borne noise;
- Description of FTA noise-sensitive land use categories;
- Identification of noise-sensitive locations along the project study corridor; and
- Measurement results for the existing noise conditions.

The noise impact analysis for the Green Line Extension project is based on the methodology defined in the FTA's guidance manual *Transit Noise and Vibration Impact Assessment*.[25] The *Noise and Vibration Technical Report* is provided in Appendix F.

### 5.8.1 Noise Definition

Noise is typically defined as unwanted or undesirable sound, where sound is characterized by small air pressure fluctuations above and below the atmospheric pressure. The basic parameters of environmental noise that affect human subjective response are (1) intensity or level; (2) frequency content; and (3) variation with time. The first parameter is determined by how greatly the sound pressure fluctuates above and below the atmospheric pressure, and is expressed on a compressed scale in units of decibels. By using this scale, the range of normally encountered sound can be expressed by values between 0 and 120 decibels. On a relative basis, a three-decibel (dB) change in sound level generally represents a barely noticeable change outside a laboratory, whereas a 10-decibel change in sound level would typically be perceived as a doubling (or halving) in the loudness of a sound.

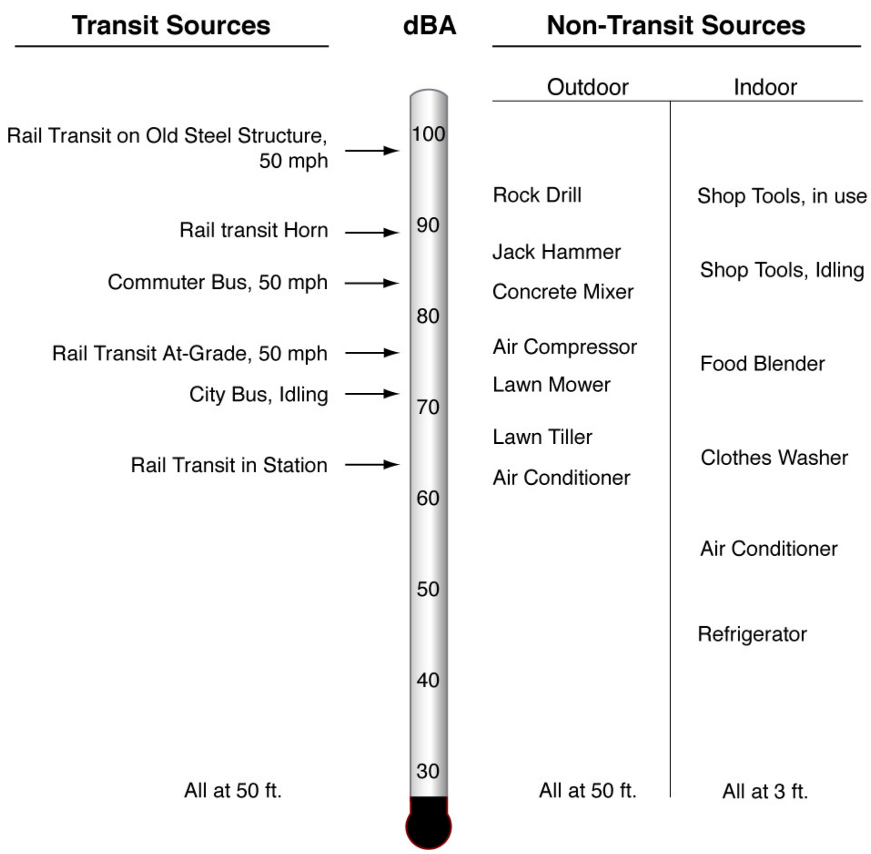
The frequency content of noise is related to the tone or pitch of the sound, and is expressed based on the rate of the air pressure fluctuation in terms of cycles per second (called Hertz and abbreviated as Hz). The human ear can detect a wide range of frequencies from about 20 Hz to 17,000 Hz. However, because the sensitivity of human hearing varies with frequency, the "A-weighting system" is commonly used when measuring environmental noise to provide a single number descriptor that correlates with human subjective response. Sound levels measured using this weighting system are called "A-weighted" sound levels, and are expressed in decibel notation as "dBA." The A-weighted sound level is widely accepted by acousticians as a proper unit for describing environmental noise. To indicate what various noise levels represent, Figure 5.8-1 shows some typical A-weighted sound levels for both

25 United States Department of Transportation, Federal Transit Administration. *Guidance Manual. Transit Noise and Vibration Impact Assessment, Report FTA-VA-90-1003-06*, May 2006. Available at: http://www.fta.dot.gov/documents/FTA_Noise_and_Vibration_Manual.pdf

transit and non-transit sources. Most commonly encountered outdoor noise sources generate sound levels within the range of 60 dBA to 90 dBA at a distance of 50 feet.

The maximum noise level (Lmax) is often used to describe individual noise events. Because environmental noise fluctuates from moment to moment, it is common practice to condense all of this information into a single number, called the "equivalent" sound level (Leq). Leq can be thought of as the steady sound level that represents the same sound energy as the varying sound levels over a specified time period (typically 1 hour or 24 hours). Often the Leq values over a 24-hour period are used to calculate cumulative noise exposure in terms of the Day-Night Sound Level (Ldn). Ldn is the A-weighted Leq for a 24-hour period with an added 10-decibel penalty imposed on noise that occurs during the nighttime hours (between 10 PM and 7 AM). Many surveys have shown that Ldn is well-correlated with human annoyance, and therefore this descriptor is widely used for environmental noise impact assessment.

**Figure 5.8-1 Typical A-Weighted Sound Levels**

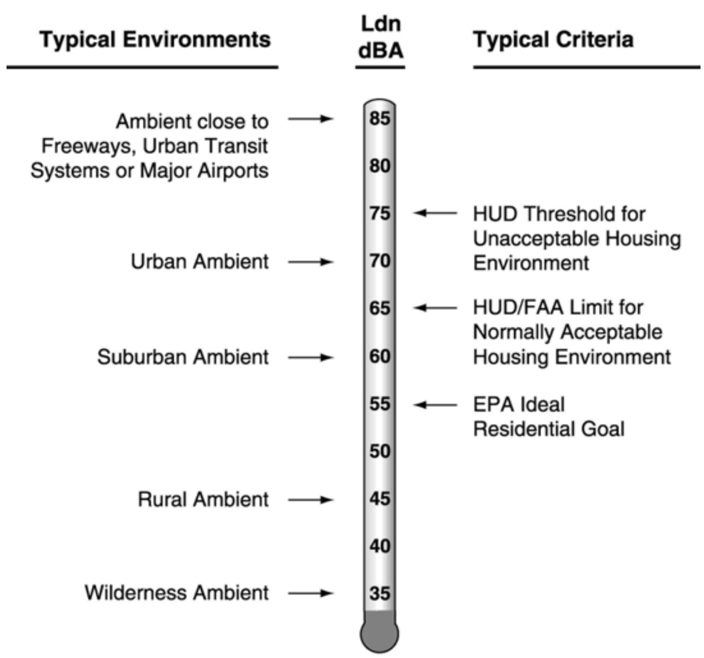



Source: Harris Miller Miller and Hanson, Inc., *Green Line Extension Noise and Vibration Technical Report*, August 2011.

Figure 5.8-2 provides examples of typical noise environments and criteria in terms of Ldn. While the extremes of Ldn are shown to range from 35 dBA in a wilderness environment to 85 dBA in noisy urban environments, Ldn is generally found to range between 55 dBA and 75 dBA in most communities. As shown in Figure 5.8-2, this spans the range between an ideal residential environment and the threshold for an unacceptable residential environment according to some Federal agencies such as HUD and the EPA.

Ground-borne noise is produced when ground-borne vibrations propagate into a room and radiate noise from the motion of the surfaces. The room surfaces are essentially acting like a giant loudspeaker from the vibrations. Ground-borne noise is perceived as a low frequency rumble and is generally considered only when airborne paths are not present (e.g., train inside a tunnel or a large masonry building with no windows or other openings to the outdoors). As presented in the following section, there are separate criteria for potential impact from airborne noise versus ground-borne noise.

**Figure 5.8-2 Examples of Typical Outdoor Noise Exposure**




Source: Harris Miller Miller and Hanson, Inc., *Green Line Extension Noise and Vibration Technical Report*, August 2011.

### 5.8.2 Noise Measurement Methodology

Existing noise measurements were conducted at representative noise-sensitive receptors. Noise impact is assessed at outdoor land uses with frequent use such as patios or pools, or at the nearest building façade. Both long-term (24-hour) and short-term (1-hour) noise measurements are conducted at these locations. Long-term measurements would provide a direct measurement of both Ldn and peak transit-hour Leq. Short-term measurements would provide a direct measurement of peak transit-hour Leq, and Ldn levels can be estimated based on methods described in the FTA guidance manual.[26]

For measurements along the existing MBTA Fitchburg Line and MBTA Lowell Line, 1-second time histories of sound levels were measured along with audio recordings of events to allow the identification of train activity. These data were the basis for allowing us to determine noise levels generated from the existing commuter trains and also the contribution of noise from trains versus other ambient sources.

Existing noise measurement sites were selected based on the location of noise-sensitive land use along the proposed corridor, their proximity to the proposed alignment and the existing terrain conditions. The distance from the measurement location to noise sources such as commuter train line or streets where there is no existing train activity was chosen to be representative of typical noise-sensitive locations in each area.

### 5.8.3 Noise-Sensitive Land Use Categories

The FTA generally classifies noise-sensitive land uses into the following three categories:

- **Category 1:** Tracts of land where quiet is an essential element in their intended purpose. This category includes lands set aside for serenity and quiet, and such land uses as outdoor amphitheaters and concert pavilions, as well as National Historic Landmarks with significant outdoor use. Also included are recording studios and concert halls.
- **Category 2:** Residences and buildings where people normally sleep. This category includes homes, hospitals, and hotels where a nighttime sensitivity is assumed to be of utmost importance.
- **Category 3:** Institutional land uses with primarily daytime and evening use. This category includes schools, libraries, theaters, and churches where it is important to avoid interference with such activities as speech, meditation, and concentration on reading material. Other places for meditation or study

26 United States Department of Transportation, Federal Transit Administration. *Guidance Manual. Transit Noise and Vibration Impact Assessment, Report FTA-VA-90-1003-06*, May 2006. Available at: http://www.fta.dot.gov/documents/FTA_Noise_and_Vibration_Manual.pdf

associated with cemeteries, monuments, museums, campgrounds and recreational facilities can also be considered to be in this category. Certain historical sites and parks are also included in Category 3.

There are some buildings, such as concert halls, recording studios and theaters that can be very sensitive to noise and/or vibration but do not fit into any of the three categories. Due to the sensitivity of these buildings, they usually warrant special attention during the environmental assessment of a transit project.

## 5.8.4 Noise Monitoring Results

This section discusses the existing noise levels and noise-sensitive land uses within the project study area.

### Existing Noise Conditions

To characterize the existing noise conditions in the project study area, 12 long-term (24-hour) and nine short-term (1-hour) measurements were conducted. Most locations adjacent to the MBTA Lowell Line and the MBTA Fitchburg Line were dominated by train activity. Figure 5.8-3 shows the noise measurement sites, and Table 5.8-1 shows the existing noise measurement results including Ldn, peak-transit hour Leq, average Lmax noise level from commuter trains, and the distance to the nearest track. The table shows that existing Ldn levels at locations with existing commuter rail train activity range from 64 to 80 dBA. MBTA commuter rail trains were found to typically generate a maximum noise level of 90 dBA and a sound exposure level (SEL) of 96 dBA at 50 miles per hour (mph) and a distance of 50 feet. Measurements of Amtrak commuter trains show that noise levels are relatively quieter than those for MBTA commuter trains. At a distance of 50 feet from the track centerline at a speed of 50 mph, an Amtrak train generates an Lmax of 81 dBA and an SEL of 86 dBA.

## Table 5.8-1 Existing Noise Measurement Results

| Measurement Site | Location | Existing Day-Night Average Sound Level (Ldn) | Existing Peak-Transit Hour Sound Level (Leq) | Commuter Train Noise Level (Lmax) [5] | Distance to Nearest Track (feet) |
|---|---|---|---|---|---|
| LT-1 | 39 Horace Street (Somerville) | 64 | 65 | 79 | 60 |
| LT-2 | 5 Alston Street (Somerville) | 74 | 73 | 89 | 65 |
| LT-3 | 283 Medford Street (Somerville) | 66 | 64 | 80 | 120 |
| LT-4 | 34 Richdale Avenue (Somerville) | 74 | 73 | 90 | 50 |
| LT-5 | 86 Vernon Street (Somerville) | 68 | 67 | 85 | 110 |
| LT-6 | 95 Boston Avenue (Somerville) | 68 | 67 | 86 | 70 |
| LT-7 | 7/9 Winchester Place (Somerville) | 77 | 76 | 93 | 55 |
| LT-8 | 131 Burget Avenue (Medford) | 71 | 69 | 89 | 60 |
| LT-9 | 76 Orchard Street (Medford) | 71 | 69 | 88 | 60 |
| LT-10 | Glass Factory Condominiums (Cambridge) | 65 [1] | 63 | n/a | n/a |
| LT-11 | Brickbottom Artists Buildings Northeast Façade (Somerville) | 64 | 63 | n/a | n/a |
| LT-12 | Brickbottom Artists Buildings South Façade (Somerville) | 67 | 65 | 87 | 88 |
| ST-1 | Water Street (Cambridge) – Hampton Inn Hotel | 58 [3] | 60 | n/a | n/a |
| ST-2 | Fitchburg Street (Somerville) – Brickbottom Lofts | 64 [2] | 61 | 78 | 65 [4] |
| ST-3 | 248 Somerville Avenue (Somerville) | 64 [3] | 66 | n/a | n/a |
| ST-4 | 2 Charlestown Street (Somerville) | 66 [2] | 64 | 82 | 150 |
| ST-5 | 45 Aldrich Street (Somerville) | 70 [2] | 62 | 87 | 50 |
| ST-6 | 81 Hinckley Street (Somerville) | 78 [2] | 72 | 96 | 50 |
| ST-7 | Colby Street (Medford) – Tufts University | 80 [2] | 76 | 99 | 50 |
| ST-8 | Water Street near MBTA Boston Engine Terminal (Cambridge) | 62 [3] | 65 | n/a | n/a |
| ST-9 | Archstone-Smith Phase II Site (Cambridge) | 65 [3] | 67 | n/a | n/a |

Source: Harris Miller Miller and Hanson, Inc., *Green Line Extension Noise and Vibration Technical Report*, August 2011 and Vanasse Hangen Brustlin, Inc. *Lechmere Station Relocation Project Environmental Assessment*, November 2006.

1 Measurements conducted March, 2006 and reported in the *Lechmere Station Relocation Project Environmental Assessment*, November 2006.

2 Ldn estimated by comparing SEL levels of train events to long-term sites whose noise environment is dominated by train noise.

3 Ldn estimated according to FTA guidance for short-term measurements conducted between 7 AM and 7 PM.

4 There is a siding track at 40 feet from the measurement location.

5 Commuter train noise level is average of all events at site.

## Noise-Sensitive Land Use

Noise-sensitive land use near the project study area includes residential properties, schools, libraries, a radio station, and other institutional sites. Parks that have passive recreation are sensitive to noise.

The existing noise environment for the project study area is generally dominated by trains on the MBTA commuter rail lines. This includes MBTA commuter trains, Amtrak regional trains (on the MBTA Lowell Line), and occasional freight activity.

### Lechmere Station to Fitchburg Street

Noise-sensitive land use between Lechmere Station and Fitchburg Street includes the existing NorthPoint Tango and Sierra residential properties, the Glass Factory Condominiums, the Hampton Inn Hotel and the Brickbottom Artists Buildings. Future proposed buildings include NorthPoint residential buildings between Water Street and Charlestown Avenue south of the MBTA Boston Engine Terminal, Archstone-Smith Phase II development residential buildings east of East Street and west of Leighton Street and a development planned at 22 Water Street. Lechmere Canal Park south of Monsignor O'Brien Highway and east of East Street is sensitive to noise.

The existing noise environment for sensitive land use in this area is dominated by vehicular traffic. On Fitchburg Street, the south side of the Brickbottom Artists Buildings is adjacent to the proposed Green Line tracks for the Union Square Branch and the existing MBTA Fitchburg Line and the northeast side of the building is adjacent to the proposed Green Line Extension tracks for the Medford Branch. The existing noise environment for the Brickbottom Artists Buildings is dominated by trains on the MBTA Fitchburg Line, consisting of commuter trains and occasional freight train activity, and by vehicular traffic on Monsignor O'Brien Highway.

Short-term (1-hour) noise measurements were conducted on the north side of the Hampton Inn Hotel on Water Street (ST-1), the south side of the Brickbottom Artists Buildings (ST-2) and the end of Water Street near the MBTA Boston Engine Terminal (ST-8). Long-term noise measurements were conducted at the Glass Factory Condominiums (LT-10), the northeast façade of the Brickbottom Artists Buildings (LT-11) and the south façade of the Brickbottom Artists Buildings (LT-12). The Ldn measured at sites LT-10, LT-11 and LT-12 were 65, 64 and 67 dBA, respectively and the estimated Ldn at ST-1 was 58 dBA and at ST-2 was 64 dBA (Table 5.8-1).

### Fitchburg Street to Union Square

The Union Square Branch corridor includes single-family residences on Horace Street, apartments on Charlestown Street, and the Walnut Street Center (a support center for adults with developmental disabilities). Existing noise levels for sensitive land use in this area is dominated by commuter rail trains on the MBTA Fitchburg

Line. A long-term (24-hour) noise measurement was conducted on Horace Street (LT-1) and two short-term noise measurements were conducted on Somerville Avenue (ST-3) and Charlestown Street (ST-4). The Ldn measured at LT-1 was 64 dBA and the estimated Ldn at sites ST-3 and ST-4 were 64 dBA and 66 dBA, respectively (Table 5.8-1).

### Fitchburg Street to McGrath Highway/Route 28

Noise-sensitive land use between Fitchburg Street and McGrath Highway along the MBTA Lowell Line includes single-family residences on Alston Street, Chester Avenue, Tufts Street, and Auburn Place. A long-term noise measurement was conducted at a single-family residence on Alston Street (LT-2). The measured Ldn at site LT-2 was 74 dBA (Table 5.8-1).

### McGrath Highway/Route 28 to School Street

Noise-sensitive land use between McGrath Highway and School Street includes multi-family residences on Medford Street, multi-family and single-family residences on Gilman Street and Aldrich Street, Somerville High School and the Somerville Public Library. Residences on Medford Street, the Somerville High School, and Public Library are on an embankment south of the MBTA Lowell Line approximately 50 feet above the tracks; residences on Gilman Street and Aldrich Street are on a slight embankment approximately 10 feet above the tracks. A long-term noise measurement was conducted on Medford Street (LT-3) and a short-term noise measurement was conducted on Aldrich Street (ST-5). The measured Ldn at site LT-3 was 66 dBA and the estimated Ldn at site ST-5 was 70 dBA (Table 5.8-1).

### School Street to Central Street

Noise-sensitive land use between School Street and Central Street includes residences on Montrose Street, Willoughby Street, and Richdale Avenue. A long-term noise measurement was conducted on Richdale Avenue (LT-4). The measured Ldn at site LT-4 was 74 dBA (Table 5.8-1).

### Central Street to Broadway

Noise-sensitive land use between Central Street and Broadway includes residences on Vernon Street, Hinckley Street, Henderson Street, Nashua Street, Murdock Street, and Boston Avenue and the Visiting Nurses Association assisted living facility on Lowell Street. According to the FTA’s noise criteria, the Park at Somerville Junction and Trum Playground are Category 3 land uses, which applies to recreational resources that are sensitive to noise. Long-term noise measurements were conducted on Vernon Street (LT-5) and Boston Avenue (LT-6) and a short-term noise measurement was conducted on Hinckley Street (ST-6). The measured Ldn at sites LT-5 and LT-6 were both 68 dBA and the estimated Ldn at site ST-6 was 78 dBA (Table 5.8-1).

### Broadway to Harvard Street

Noise-sensitive land use between Broadway and Harvard Street includes single-family residences on Winchester Court, Winchester Place, Granville Avenue, Morton Avenue, Newbern Avenue, and a condominium complex on Boston Avenue. Grant Park south of Boston Avenue and East of Winthrop Street is sensitive to noise. A long-term noise measurement was conducted on Winchester Place (LT-7). The measured Ldn at site LT-7 was 77 dBA (Table 5.8-1).

### Harvard Street to College Avenue

Noise-sensitive land use between Harvard Street and College Avenue include institutional buildings on Colby Street and Boston Avenue. These institutional buildings include the Science and Technology Center, Bacon Hall, Bray Laboratories, Psychology Building and Curtis Hall at Tufts University, and the Outside the Lines Artist Studio (a teaching facility). The Science and Technology Center includes classrooms and laboratories. Bacon Hall, which includes the Avian Visual Cognition Lab, is sensitive to ground-borne, rather than airborne, noise since it has no windows facing the alignment and there are no dominant airborne noise paths. Curtis Hall includes the WMFO radio station which has been assessed as a recording studio and is sensitive to ground-borne noise. Future classrooms, labs and/or contain equipment sensitive to noise are proposed at an Integrated Research Lab (550 to 574 Boston Avenue) at Tufts University.

A short-term noise measurement near the Outside the Lines Studio and Tufts Memorial Field was conducted (ST-7). The estimated Ldn at site ST-7 was 80 dBA (Table 5.8-1).

### College Avenue to Brookings Street

Noise-sensitive land use between College Avenue and Winthrop Street include single-family residences on Burget Avenue and Brookings Street. A long-term noise measurement was conducted on Burget Avenue (LT-8). The measured Ldn at site LT-8 was 71 dBA (Table 5.8-1).

## 5.9 Vibration

This section describes the methodology used to characterize the existing noise and vibration conditions, including:

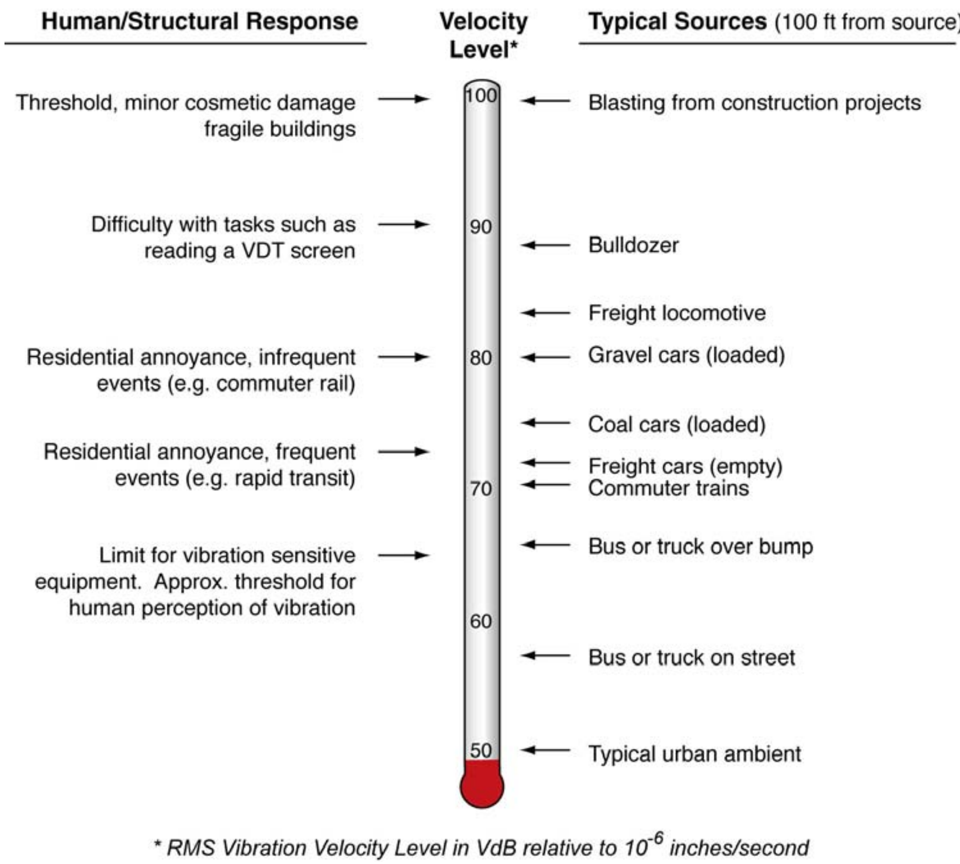
- Background information on vibration;
- Description of FTA vibration-sensitive land use categories;
- Identification of vibration sensitive locations along the corridor; and
- Measurement results of the existing vibration conditions.

The vibration impact analysis for the Green Line Extension project is based on the methodology defined in the FTA guidance manual *Transit Noise and Vibration Impact Assessment*.[27] The noise and vibration technical memorandum is provided in Appendix F, *Noise and Vibration Technical Report*.

### 5.9.1 Vibration Definition

Ground-borne vibration is the oscillatory motion of the ground about some equilibrium position that can be described in terms of displacement, velocity, or acceleration. Because sensitivity to vibration typically corresponds to the vibration velocity amplitude in the low-frequency range of most concern for environmental vibration (roughly 4 to 80 Hz), velocity is the preferred measure for evaluating ground-borne vibration from transit projects.

**Figure 5.9-1 Typical Ground-Borne Vibration Levels and Criteria**




Source: Harris Miller Miller and Hanson, Inc., *Green Line Extension Noise and Vibration Technical Report*, August 2011.

27 United States Department of Transportation, Federal Transit Administration. *Guidance Manual. Transit Noise and Vibration Impact Assessment, Report FTA-VA-90-1003-06*, May 2006. Available at: http://www.fta.dot.gov/documents/FTA_Noise_and_Vibration_Manual.pdf

Ground-borne vibration is typically characterized in terms of the "smoothed" root-mean-square (RMS) vibration velocity level, in vibration decibels (VdB), with a reference quantity of one micro-inch per second. VdB is used in place of dB to avoid confusing vibration decibels with sound decibels. Vibration levels in terms of RMS velocity have been found to correlate most suitably to human response to vibration in buildings and RMS velocity is the metric commonly used in American and International standards.

Figure 5.9-1 illustrates typical ground-borne vibration levels for common sources as well as criteria for human and structural response to vibration. As shown, the range of interest is from approximately 50 to 100 VdB, from imperceptible background vibration to the threshold of damage. Although the approximate threshold of human vibration perception is 65 VdB, annoyance is usually not expressed unless the vibration exceeds 70 VdB.

Ground-borne noise is produced when ground-borne vibrations propagate into a room and radiate noise from the motion of the surfaces. The room surfaces are essentially acting like a giant loudspeaker from the vibrations. Ground-borne noise is perceived as a low frequency rumble and is generally considered only when airborne paths are not present (e.g., train inside a tunnel or a large masonry building with no windows or other openings to the outdoors). Ground-borne noise is assessed according to the A-weighted sound level in dBA. As presented in Section 5.8, *Noise*, there are separate noise criteria for potential impact from airborne noise versus ground-borne noise.

### 5.9.2 Vibration Measurement Methodology

Characterizing the existing vibration conditions included measurements of commuter trains and Green Line trains along the project study area and measurements of the vibration propagation characteristics of the soil. Vibration propagation measurements sites were selected based on the ability to conduct measurements at distances up to 200 feet from the tracks along sections without special trackwork. The line source transfer mobility (LSTM) of the soil was measured to characterize the vibration propagation conditions of the soil. The force density of the commuter trains and Green Line trains was calculated by measuring both the vibration levels from the trains and the propagation characteristics of the soil at the same location. The force density was used to project future vibration levels from new transit sources such as the proposed Green Line trains and the commuter trains including any modifications to the alignment. The Green Line vehicle force density was measured on the existing D branch near Beaconsfeld Station and the MBTA commuter train force density was measured at Tufts University Alumni Field. The vibration propagation characteristics of the soil along the Proposed Action were measured at three locations including 200 Inner Belt Road, 20 Vernon Street and Tufts University Alumni Field. Vibration measurement locations are shown in Figure 5.8-3.

Vibration measurements were also conducted at eight locations with existing commuter trains and one location with Green Line trains on elevated structures along the proposed corridor to provide further detail on vibration generated by these sources. These locations include the Archstone-Smith Phase II development parcel east of East Street, Horace Street, Aldrich Street, Pearl Street Apartments, Richdale Avenue, Cedar Street, Nashua Street, Morton Avenue and Tufts Science and Technology Center. This information was used to identify the frequency content of vibration generated by the trains and would be used to specify appropriate track vibration isolation during the final design of the Proposed Action.

These measurements are conducted with high-sensitivity accelerometers at specific distances away from the rail alignment. The acceleration signals are recorded onto a multi-channel digital recorder and subsequently analyzed using digital signal processing software. Vibration propagation measurements are conducted by dropping a 60-pound weight onto a load cell to generate vibrations with a known force and measuring the vibration response at accelerometers at several distances setback from the source.

### 5.9.3 Vibration-Sensitive Land Use Categories

The FTA generally classifies vibration-sensitive land uses into the same three categories as noise. However, outdoor land uses are not considered to be sensitive. In addition to the potential for human annoyance from vibration, vibration impact is also assessed for certain equipment that is sensitive to vibration.

- **Vibration Category 1 – High Sensitivity**: Included in this category are buildings where vibration would interfere with operations. Vibration levels may be well below those associated with human annoyance. These buildings include vibration-sensitive research and manufacturing facilities, hospitals with sensitive equipment, and university research operations. The sensitivity to vibration is dependent on the specific equipment present. Some examples of sensitive equipment include scanning electron microscopes, magnetic resonance imaging scanners, and lithographic equipment.
- **Vibration Category 2 – Residential**: Residences and buildings where people normally sleep. This category includes homes, hospitals, and hotels.
- **Vibration Category 3 – Institutional**: This category includes buildings with primarily daytime and evening use. This category includes schools, libraries, and churches.

Special-use buildings such as concert halls, recording studios, auditoriums and theatres warrant special consideration. Potential ground-borne vibration and ground-borne noise impact is assessed at these buildings.

### 5.9.4 Existing Vibration Conditions

Line source transfer mobility (LSTM) measurements and vibration levels of existing commuter trains and Green Line trains on elevated structures were conducted throughout the project study area. Table 5.9-1 lists the vibration measurement locations in the project study area. These measurement locations are also shown on Figure 5.8-3.

**Table 5.9-1 Vibration Measurement Locations**

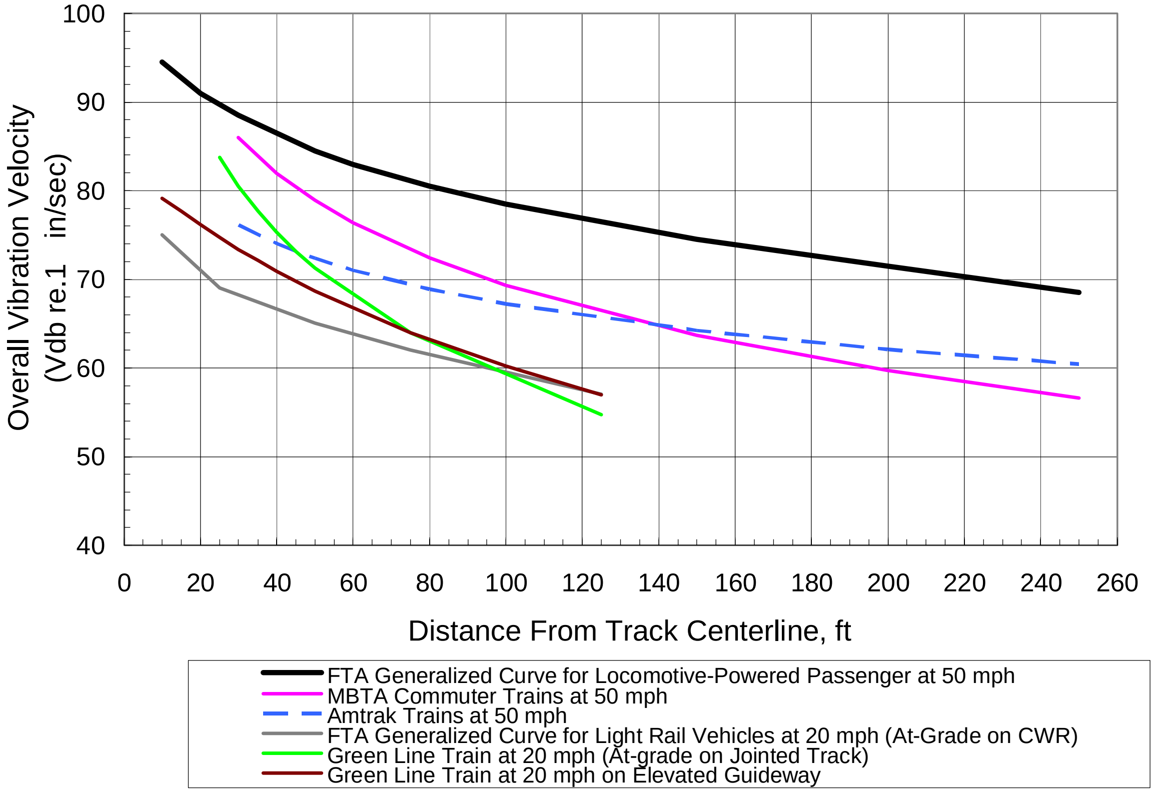
| Measurement Site | Location | Measurement Type |
|---|---|---|
| V-1 | 200 Inner Belt Road (Cambridge) | LSTM |
| V-2 | 20 Vernon Street (Somerville) | LSTM |
| V-3a | Tufts University Alumni Field (Medford) | LSTM/ Commuter Train Force Density |
| V-3b | Tufts University Alumni Field (Medford) | Commuter Train |
| V-4 | Archstone-Smith Phase II Site (Cambridge) | Elevated Green Line |
| V-5 | 39 Horace Street (Somerville) | Commuter Train |
| V-6 | 45 Aldrich Street (Somerville) | Commuter Train |
| V-7 | Pearl Street Apartments (Somerville) | Commuter Train |
| V-8 | 26 Richdale Avenue (Somerville) | Commuter Train |
| V-9 | 39 Nashua Street (Somerville) | Commuter Train |
| V-10 | Trum Field/Cedar Street (Somerville) | Commuter Train |
| V-11 | 85 Morton Avenue (Medford) | Commuter Train |
| V-12 | Tufts Science and Technology Center (Medford) | Commuter Train |

Source: Harris Miller Miller and Hanson, Inc., *Green Line Extension Noise and Vibration Technical Report*, August 2011.

Figure 5.9-2 shows the maximum overall vibration levels for each train type as a function of distance and the typical FTA generalized curve for locomotive-powered passenger trains at 50 mph and the typical FTA generalized curve for light-rail vehicles at-grade at 20 mph. This figure shows that the vibration levels from the MBTA commuter and Amtrak trains are about 5 to 10 VdB lower than the generalized curve. Amtrak commuter trains operating at 50 mph are shown to generate maximum vibration levels of approximately 72 VdB at a distance of 50 feet from the track centerline. Since the MBTA commuter trains were found to generate higher vibration levels than Amtrak trains (at distances within 150 feet of the near track centerline where impact may occur) and the vibration impact criteria are based on maximum levels of either type of commuter train, the assessment focuses on vibration generated by the MBTA commuter trains rather than Amtrak trains.

Figure 5.9-2 also shows that the vibration levels from the Green Line trains at-grade are up to 10 VdB higher than the FTA generalized curve for light-rail vehicles at close-in distances. This may be due to the jointed track causing localized increases in vibration levels close to the tracks. Vibration levels from Green Line trains on elevated structures are shown to be lower than for trains at-grade, especially close-in to the guideway support column. Vibration levels are typically lower on elevated structures compared to at-grade because the vibrations need to propagate through the elevated structure into support columns and then into the surrounding ground.

**Figure 5.9-2 Vibration Levels of Selected Trains and FTA Generalized Curves**




Source: Harris Miller Miller and Hanson, Inc., *Green Line Extension Noise and Vibration Technical Report*, August 2011.

## 5.9.5 Vibration-Sensitive Land Use

Vibration-sensitive land uses near the project study area include residential properties, schools, libraries and other institutional sites. Land uses along various segments of the proposed Green Line Extension project are described in the following paragraphs. Vibration measurement locations within each segment are also identified.

### Lechmere Station to Fitchburg Street

Vibration-sensitive land use between Lechmere Station and Fitchburg Street includes the existing NorthPoint Tango and Sierra residential properties, the Glass Factory Condominiums, the Hampton Inn Hotel, and the Brickbottom Artists Buildings. Future land use in this segment includes NorthPoint residential buildings between Water Street and Charlestown Avenue south of the MBTA Boston Engine Terminal, Archstone-Smith Phase II development residential buildings east of East Street and west of Leighton Street, and a residential development planned at 22 Water Street.

Vibration transfer mobility measurements were conducted in the field across from 200 Inner Belt Road to characterize the efficiency of vibration propagation in the region of the Proposed Action between the relocated Lechmere Station and Walnut Street and the Union Square Branch. Vibration measurements of Green Line trains on an elevated structure were conducted at the Archstone-Smith Phase II development parcel east of East Street on Monsignor O'Brien Highway in Cambridge.

### Fitchburg Street to Union Square

The area along the Green Line Extension branch line to Union Square includes single-family residences on Horace Street, apartments on Charlestown Street and the Walnut Street Center (a support center for adults with developmental disabilities). Vibration measurements of existing commuter trains were conducted at the end of Horace Street.

### Fitchburg Street to McGrath Highway/Route 28

Vibration-sensitive land use between Fitchburg Street and McGrath Highway/ Route 28 along the MBTA Lowell Line includes single-family residences on Alston Street, Chester Avenue, Tufts Street and Auburn Place.

### McGrath Highway/Route 28 to School Street

Vibration-sensitive land use between McGrath Highway/Route 28 and School Street includes multi-family residences on Medford Street, multi-family and single-family residences on Gilman Street and Aldrich Street, Somerville High School, and the Somerville Public Library. Residences on Medford Street, the Somerville High School, and Public Library are on an embankment south of the MBTA Lowell Line approximately 50 feet above the tracks; residences on Gilman Street and Aldrich Street are on a slight embankment approximately 10 feet above the tracks. Vibration measurements of existing commuter trains were conducted at the end of Aldrich Street and at Pearl Street Apartments.

### School Street to Central Street

Vibration-sensitive land use between School Street and Central Street includes residences on Montrose Street, Willoughby Street, and Richdale Avenue. Vibration measurements of existing commuter trains were conducted on Richdale Avenue.

### Central Street to Broadway

Vibration-sensitive land use between Central Street and Broadway includes residences on Vernon Street, Hinckley Street, Henderson Street, Nashua Street, Murdock Street, and Boston Avenue and the Visiting Nurses Association Assisted Living Community on Lowell Street. Vibration transfer mobility measurements were conducted in the parking lot of 20 Vernon Street to characterize the efficiency of vibration propagation in the region of the Proposed Action between Walnut Street and Cedar Street. Vibration measurements of existing commuter trains were conducted at the end of Nashua Street and at Trum Playground on Cedar Street.

### Broadway to Harvard Street

Vibration-sensitive land use between Broadway and Harvard Street includes single-family residences on Winchester Court, Winchester Place, Granville Avenue, Morton Avenue, Newbern, and a condominium complex on Boston Avenue. Vibration measurements of existing commuter trains were conducted at the end of Morton Avenue.

### Harvard Street to College Avenue

Vibration-sensitive land use between Harvard Street and College Avenue includes institutional buildings on Colby Street and Boston Avenue. These institutional buildings include the Science and Technology Center, Bacon Hall, Bray Laboratories, the Psychology Building, Curtis Hall at Tufts University, and the Outside the Lines Artist Studio (teaching facility). The Science and Technology Center includes classrooms and general vibration-sensitive equipment. Bacon Hall includes vibration-sensitive equipment within the Avian Visual Cognition Lab. Bray Laboratories includes vibration-sensitive equipment within the Superconductivity and Fusion Research Lab. The Psychology Building includes vibration-sensitive equipment such as a magnetic resonance imaging (MRI) machine. Curtis Hall includes the WMFO radio station which has been assessed as a recording studio and is sensitive to ground-borne noise and vibration. Future proposed properties which may include classrooms, labs and/or contain vibration-sensitive equipment include an Integrated Research Lab (550 to 574 Boston Avenue) at Tufts University.

Vibration measurements were taken at this location to quantify the existing vibration levels of trains traveling on the MBTA Lowell Line. Vibration transfer mobility measurements were conducted to characterize the efficiency of vibration propagation in the region of the Proposed Action between Cedar Street and the western terminus. Additional vibration measurements of existing commuter trains were also conducted near the Tufts Science and Technology Center building.

### College Avenue to Brookings Street

Vibration-sensitive land use between College Avenue and Winthrop Street include single-family residences on Burget Avenue and Brookings Street.

## 5.10 Stormwater

This section introduces the major concepts relevant to stormwater management, summarizes the existing stormwater drainage system in Cambridge, Somerville, and Medford, and discusses the relationship between stormwater drainage and local water resources. Figure 5.10-1 shows the watersheds in the project study area.

### 5.10.1 Stormwater Definition

Stormwater from urban areas typically contains contaminants that are washed off of paved surfaces during storms. Roads and parking lots can contribute metals, hydrocarbons, salts, sediments, and other substances to runoff, adversely affecting water quality. The accumulation of pollutants from vehicles on road surfaces is primarily related to vehicle traffic volumes.[28] Urbanized areas are also common sources of bacteria from uncontrolled pet waste and from cross-connections between storm drains and the sanitary sewers. Both the mass and concentration of pollutants carried in stormwater runoff may have adverse effects on an aquatic ecosystem if the ecosystem's ability to process those pollutants is exceeded. To reduce these problems, most stormwater systems include measures to prevent or reduce water contamination, including simple grates to screen out trash, settling basins to collect suspended particles, and specialized structures to separate oil and floating debris. Additional measures may be used to protect especially sensitive water bodies from contamination and impairment.

Stormwater management considers:

- The amount and type of development that has taken place in a watershed, which affects both the quantity of impervious surface and the types of potential contaminant sources;
- The design of the stormwater system, which includes any measures to reduce flow rates, prevent flooding, and control contaminants; and
- The quality of the receiving water body that may be impacted by stormwater discharges.

### 5.10.2 Regional Context

This section describes the Charles River and Mystic River watersheds where the Cities of Cambridge, Medford, and Somerville are located. These waterbodies would receive stormwater runoff from the Proposed Action.

28 United States Department of the Interior, United States Geological Survey. Buckler & Granato. *Assessing Biological Effects from Highway-Runoff Constituents*, 1999 (Page 16). Available at: http://204.202.251.206/assets/135PLUSGSBiological.pdf

Cambridge is an urban city predominantly within the Charles River watershed. The Charles River is 80 miles long, flowing from Hopkinton to Boston Harbor. The watershed comprises 308 square miles and is the most densely populated watershed in New England.[29] The section of the Charles River in Cambridge is listed on the Massachusetts Clean Water Act Section 303(d) list as a Category 5 impaired water body, which indicates that it is not supporting its designated uses. This segment of the river is impaired due to chlorophyll, dichlorodiphenyltrichloroethane (DDT), dissolved oxygen (DO) saturation, excess algal growth, oil and grease, salinity, nutrients/eutrophication biological indicators, taste and odor, total phosphorus, sediments, and polychlorinated biphenyls (PCB) in fish tissue.[30]

An unnamed tributary to the Charles River, locally known as Millers River, is a small waterway that flows into the Charles River in Cambridge, between the Leonard Zakim Bridge and the Commuter Rail bridge (Figure 5.10-1). Millers River is classified as a Category 5 impaired water body due to: foam/flocs/scum/oil slicks, habitat assessment (streams), PCBs, sedimentation/siltation, polycyclic aromatic hydrocarbons (PAH), taste and odor, bottom deposits, and petroleum hydrocarbons.[31]

Somerville and Medford are both urban cities predominantly within the Mystic River watershed. The Mystic River is the largest waterway in both cities and its water quality is impaired by a number of environmental hazards. Water levels in the Mystic River are controlled by the Amelia Earhart Dam, which was constructed in 1966 and is near the confluence of the Mystic River and the Malden River near the Fellsway West (Route 28) bridge. The dam separates the lower Mystic River from the majority of its watershed upstream, causing a buildup of contaminated sediments behind the dam and impeding the migration of diadromous fish. The watershed as a whole (76 square miles) also includes a number of contaminant sources, including waste disposal sites, contaminated sediments, and bacteria discharges such as CSOs.

Between Lower Mystic Lake and the Amelia Earhart Dam, the Mystic River is a Class B warm-water fishery, which designates waterways that are not used for drinking water but should have adequate quality for aquatic life, recreational uses, and fish consumption. This section of the Mystic River is listed on the Massachusetts Clean Water Act Section 303(d) list as impaired (and therefore not supporting its intended uses) due to pesticides, priority organics, metals, nutrients, and pathogens. Downstream of the dam, the lower Mystic River is listed as a Class SB water, which applies to saltwaters intended to support aquatic life, recreational uses, and fish/shellfish consumption. This section of the Mystic River is impaired due to excess organics, unspecified inorganics, metals, un-ionized ammonia, pathogens, oil and

29 Charles River Watershed Association, *2009 Annual Report*, page 16. Available at: http://www.crwa.org/annreports/AR2009_fullcolor.pdf

30 Commonwealth of Massachusetts, Executive Office of Energy and Environmental Affairs. *Massachusetts Year 2010 Integrated List of Waters*. Prepared by Division of Watershed Management. April 2010, page 109. Available at: http://www.mass.gov/dep/water/resources/10list3.pdf

31 Commonwealth of Massachusetts, Executive Office of Energy and Environmental Affairs. *Massachusetts Year 2010 Integrated List of Waters*. Prepared by Division of Watershed Management. April 2010, page 116. Available at: http://www.mass.gov/dep/water/resources/10list3.pdf

grease, as well as low DO and aesthetic issues such as poor taste, odor, and color.[32] The numerous urban stormwater discharges into the Mystic River have been cited as the main source of its impairments.[33]

Communities upstream of Somerville and Medford also affect the Mystic River. For example, Cambridge has multiple CSOs that discharge to Alewife Brook (a tributary to the Mystic River) upstream of Somerville's discharges (Figure 5.10-1). CSOs allow combined sewer and stormwater drainage systems to discharge to surface waters when storm events overwhelm the system's capacity. This can lead to discharges of untreated sewage during large storms and impairment of the receiving waters. Alewife Brook is also listed on the Massachusetts 303(d) list as impaired due to excess metals, nutrients, pathogens, oil and grease, as well as low DO and aesthetic issues such as poor taste, odor, and color.[34] Urban communities such as Cambridge, Somerville, and Medford are authorized to discharge stormwater in accordance with the National Pollutant Discharge Elimination System (NPDES) Small Municipal Separate Storm Sewer System (MS4) General Permit. The MS4 General Permit includes numerous requirements to improve stormwater management through public education, upgraded infrastructure, and municipal bylaws. The permit also requires cities to locate and correct any unauthorized sewage discharges into the stormwater system.

## 5.10.3 Rail Corridors

Most of the Green Line Extension project would be constructed in existing rail corridors or previously developed urban lands. The existing drainage systems within the rail rights-of-way consist of a network of underdrains and a few drains that intercept runoff. Due to the corridor's narrow width, drainage ditches are limited to the Medford Branch terminus area north of College Avenue. The ditches and underdrains convey the runoff to a trunkline that discharges to any one of several outfalls on the Mystic River and the Millers River (as noted above, a tributary to the Charles River).

## 5.10.4 Cambridge

The City of Cambridge Department of Public Works has been working towards separating their sewer and stormwater systems since the 1930s. The city's collection system currently include approximately 110 miles of sanitary sewer, 94 miles of stormwater drains, and 41 miles of combined sewer. Approximately 40 percent of the

32 Massachusetts Department of Environmental Protection: Division of Watershed Management. *Massachusetts Year 2010 Integrated List of Waters*. (2010), Page 99.Available at: http://www.mass.gov/dep/water/resources/10list3.pdf

33 City of Somerville, Massachusetts. *Developing an Innovative Model for Cost Effective Asset Management and Pollution Prevention in a Municipal Storm Water System*. (2005), Page 6.

34 Massachusetts Department of Environmental Protection: Division of Watershed Management *Massachusetts Year 2010 Integrated List of Waters*. (2010), Page 97. Available at: http://www.mass.gov/dep/water/resources/10list3.pdf

Cambridge collection system has been separated. During large storm events, CSOs in Cambridge discharge to the Charles River at five locations and into Alewife Brook at six locations.

The City of Cambridge, in an effort to comply with the EPA's MS4 stormwater management program, has created a Stormwater Management Plan. The plan addresses illicit discharge detection and elimination, construction site runoff control, and pollution prevention and good housekeeping for municipal operations, among other subjects.[35] Best management practices conducted by the city include catch basin cleaning, street sweeping, and implementing an urban forestry program.

## 5.10.5 Somerville

Approximately two-thirds of Somerville's streets use a combined sewer system in which both stormwater and domestic sewage are conveyed in the same pipe and treated at the MWRA's Deer Island wastewater facility. The remainder of the city has a separate stormwater system that discharges to the Mystic River or one of its tributaries.[36] Somerville also has four CSOs, all discharging to the Mystic River and its tributaries (Figure 5.10-1). The discharge of untreated sewage (combined with stormwater runoff) to the Mystic River during large storms increases the risk to human health and makes the river temporarily unusable for recreational purposes.

Physical controls to manage stormwater and improve its quality in Somerville include street sweeping and annual catch basin maintenance. Additional structural improvements such as hooded outlets in catch basins have not been implemented at this time. However, state grants have been used to install treatment structures on Alewife Brook, including a StormTreat system that uses vegetation and gravel filters to improve water quality and promote infiltration.

## 5.10.6 Medford

In Medford, stormwater is discharged directly to the Mystic River or one of its tributaries through nearly 100 separate stormwater outfalls. Several culverted streams, such as Meetinghouse Brook, Two Penny Brook, and Winter Brook are integral parts of Medford's separate stormwater system (Figure 5.10-1). Although Medford's separate stormwater system does not include any CSOs, there are utility systems in Medford (such as the MWRA sewer line and stormwater cross-connections with Somerville) that are not under Medford's control and may

35 City of Cambridge, Massachusetts. *NPDES Phase II Final Rule Notice of Intent and Stormwater Management Plan*, 2006 (Page A-1). Available at: http://www2.cambridgema.gov/TheWorks/stormwater/pdffiles/SECONDDraftCambridgeStormwaterManagementPlanandNOI_April%202006.pdf

36 City of Somerville, Massachusetts. *Developing an Innovative Model for Cost Effective Asset Management and Pollution Prevention in a Municipal Storm Water System*, 2005 (Page 9).

contain relief outlets or illicit discharges contributing sewage or other contamination to the Mystic River.

Physical controls to manage stormwater and improve its quality in Medford include street sweeping and annual catch basin maintenance. Additional structural improvements such as hooded outlets in catch basins have not been implemented at this time. Medford has developed training programs, city ordinances, and fines to encourage both municipal employees and the general public to prevent common sources of water pollution such as littering, pet waste, and illicit discharges.

## 5.11 Wetlands

There are no state or Federally regulated wetlands within the project study area. Site investigations identified one potential wetland area, an isolated ditch within the MBTA Lowell Line right-of-way at Cedar Street in Somerville. The ditch was determined to be non-jurisdictional by the Somerville Conservation Commission.

## 5.12 Fish, Wildlife and Plants

No Federal or state-listed endangered or threatened species are present within the project study area. Portions of the project study area along the MBTA Lowell Line provide habitat for urban wildlife species. Throughout much of the project study area there is a narrow fringe of vegetation (generally 30 to 40 feet wide) between the commuter rail tracks and the limits of the right-of-way. This fringe of vegetation is absent where the tracks are directly bordered by retaining walls, buildings or parking lots. Vegetated areas primarily occur between Fitchburg Street and Washington Street; between McGrath Highway/Route 28 and Medford Street; between School Street and Central Street; between Central Street and Lowell Street; and between College Avenue and Winthrop Street in Medford.

The vegetation in most of these areas is dominated by non-native and invasive species, including Norway maple (*Acer platanoides*), tree of heaven (*Ailanthus altissima*), catalpa (*Catalpa speciosa*), rock (sycamore) maple (*Acer pseudoplatanus*), and oriental bittersweet (*Celastrus orbiculatus*). Other dominant species include goldenrods (*Solidago* spp.), poison ivy (*Toxicodendron radicans*), and grasses (primarily *Agrostis* sp.). This plant community provides limited wildlife habitat due to the narrow width, lack of shrub stratum, sparse herbaceous layer, and few food resources for wildlife. Some common suburban wildlife species could use the habitat for feeding or nesting, such as gray squirrel, American robin, gray catbird, or downy woodpecker. During field investigations, a groundhog (*Marmota monax*) was observed in the segment north of School Street.

The vegetation near the Medford Branch terminus, between College Avenue and just north of Winthrop Street, has a more diverse plant community. In addition to the species listed above, this area includes native tree species (red oak, *Quercus rubra*; pin oak, *Quercus palustris*; silver maple, *Acer saccharinum;* black cherry, *Prunus serotina;* and gray birch, *Betula populifolia*) and native herbaceous species (hay-scented fern, *Dennstaedtia punctilobula*; and tree clubmoss, *Lycopodium obscurum*). This plant community contains good wildlife food resources (acorns, birch seeds, cherry), a denser sapling layer, and a denser herbaceous layer that provides cover for small animals. In addition to the species listed above, this habitat could also provide feeding or nesting habitat for blue jay, common grackle, mourning dove, chipping sparrow, white-footed deer mouse, and chipmunk. Red-tailed hawks have been observed feeding, roosting and potentially nesting in this area. Red-tailed hawks are common urban/suburban raptors.

## 5.13 Parks and Recreation Areas

Certain public parks, recreation areas, and conservation lands are subject to Section 4(f) provisions of the U.S. DOT Act of 1966[37] and the Commonwealths' Article 97 Land Disposition Policy.[38] Section 4(f) provides protection for publicly owned parks, recreation areas, wildlife and waterfowl refuges, and historic properties or archeological sites on or eligible for listing on the National Register of Historic Places (the National Register). A complete evaluation of Section 4(f) resources is provided in Chapter 8, *Section 4(f) Evaluation*, of this EA. Historical and archeological sites are also described in Section 5.15, *Cultural Resources*.

This section identifies and describes public parks and recreation areas within the project study area (Table 5.13-1). The study area for parks and recreational areas is defined as a linear area extending approximately 100 feet on either side of the proposed Medford and Union Square branches, and a 100-foot radius around the proposed station locations and maintenance and storage facility site. This area encompasses the construction limits of the project and the associated area of potential impacts (physical disturbance, increases in noise or vibration, changes in the visual environment or access, etc.). No public school playgrounds were identified within 100 feet of the Proposed Action. These resources were identified using MassGIS data and information provided by the municipalities of Somerville, Cambridge, and Medford. Additionally, no conservation lands subject to Section 4(f) are within the project study area. Data used to identify which of these facilities are subject to Section 4(f) were obtained from public agencies having jurisdiction over public lands and recreational facilities.

37 *Section 4(f) of the United States Department of Transportation Act of 1966* (Amended March 12, 2008 in 73 FR 13395; implemented at 23 U.S.C. 138 and recodified at 49 USC, Subtitle I, Section 303(c)). Available at: http://www.gpo.gov/fdsys/pkg/FR-2008-03-12/pdf/E8-4596.pdf

38 Commonwealth of Massachusetts, Executive Office of Energy and Environmental Affairs. *Article 97 Land Disposition Policy*, February 19, 1998. Available at: http://www.env.state.ma.us/mepa/article97policy.aspx

**Table 5.13-1 Existing Park and Recreation Areas within 100 Feet of the Project Corridor**

| Property | Location | Size *(acres)* | Ownership | Type of Property | Primary (Designated) Use of Property |
|---|---|---|---|---|---|
| Trum Playground | Cedar Street at Franey Road | 0.39 | City of Somerville | Public Recreation Area | Passive Recreation, Playground |
| Park at Somerville Junction | Centre Street at Woodbine Street | 0.50 | City of Somerville | Public Park | Passive Recreation, Picnic Areas, Running, Bicycling, Walking |
| Hoyt-Sullivan Playground | Central Street | 0.38 | City of Somerville | Public Recreation Area | Active Recreation, Playground, Basketball |
| Lechmere Canal Park | Edward Land Boulevard | 4.39 | City of Cambridge | Public Park | Passive Recreation, Picnic Areas, Running, Bicycling, Walking |

Two public parks and two public recreation areas were identified within 100 feet of the project corridor and are described below (Table 5.13-1).

- Lechmere Canal Park (Figure 5.1-1) is southeast of the CambridgeSide Galleria Mall, off of Edwin H. Land Boulevard in Cambridge. This park offers a scenic area for passive recreational opportunities such as picnic areas, walking, running, and bicycling. Lechmere Canal Park is owned and operated by the City of Cambridge.
- Hoyt-Sullivan Playground (Figure 5.1-6) is on Central Street between Pembroke Street and the railroad bridge in Somerville. This public recreation area contains children's playground equipment and a basketball court. Hoyt-Sullivan Playground is owned and operated by the City of Somerville.
- The Park at Somerville Junction (Figure 5.1-6) is at the corner of Woodbine Street and Centre Street, adjacent to the existing commuter rail line. This park includes a lawn and seating area, with a biking and walking path that is intended to connect the future Community Path. The Park at Somerville Junction is owned and operated by the City of Somerville.
- Trum Playground (Figure 5.1-7) is at the corner of Cedar Street and Franey Road, across from Trum Field in Somerville. This public recreation area contains playground equipment and benches. Trum Playground is owned and operated by the City of Somerville.

## 5.14 Visual Environment

Detailed information on the existing developed and natural environment is provided in Section 4.4, *Proposed Action*, which discusses the major features of the railroad corridor and of each proposed station location, Section 5.2, *Land Use*, which discusses existing land uses, and Section 5.12, *Fish, Wildlife, and Plants*, which discusses the natural resources found within the project study area. The following paragraphs summarize these observations in the context of the visual environment.

The project study area is an existing rail corridor bordered by urban neighborhoods and commercial/industrial development. The majority of the rail corridor is occupied by active commuter rail lines, which is primarily below grade and visible from only adjacent buildings and roadway bridges over the rail lines. The commuter rail trains are diesel powered, and therefore do not require overhead electrical power infrastructure (catenary system). A short section of the proposed Green Line Extension, from the proposed relocated Lechmere Station site to the Union Square Branch's intersection with the MBTA Lowell Line just west of the MBTA Boston Engine Terminal, would follow the abandoned B&M railroad spur right-of-way paralleling McGrath Highway/Route 28.

The areas bordering the active rail corridor consist mostly of residences with some commercial and industrial uses and mixed-use buildings. A broad range of building ages is represented within the project study area, with most buildings constructed in the 1900s. Natural visual resources around the project study area consist mostly of isolated patches and strips of low-diversity vegetation. The visual environment in the vicinity of the B&M railroad spur segment is mixed residential, commercial, and industrial. The spur alignment passes to the east side of the Glass Factory Condominiums and the Hampton Inn. The spur is on the west side of the partially completed NorthPoint development and southwest of the MBTA Boston Engine Terminal.

The Option L maintenance and storage facility site is immediately adjacent to the MBTA Boston Engine Terminal, on the northwest. The Option L site is along the southern and southeastern fringe of the Inner Belt industrial area.

The existing Lechmere Station is at the end of an elevated viaduct that crosses the Charles River, parallels Monsignor O'Brien Highway on the east side for a short distance, and then crosses the highway to descend to the ground-level station site (which includes a bus shelter) and a loop track on the west side of the highway. The elevated viaduct is a steel structure, similar in appearance to a bridge, and transitions to a concrete abutment on the west side of Monsignor O'Brien Highway as the tracks slope to the ground surface. The existing Lechmere Station is a simple building of industrial appearance, as is the adjacent bus shelter.

Due to the urbanized character of the portions of Cambridge, Somerville, and Medford involved, there are no other noteworthy visual resources associated with the project.

## 5.15 Cultural Resources

A historic and archeological resources reconnaissance survey for the Green Line Extension project was undertaken as the first step in fulfilling compliance responsibilities regarding cultural resources under Section 106 of the NHPA as amended, the regulations of the Advisory Council on Historic Preservation (Council) at 36 CFR 800, NEPA, and Section 4(f) of the U.S. DOT Act. The historic reconnaissance survey is provided in Appendix I, *Historic Resources Reconnaissance survey and Historic Resources Intensive Survey*. The complete evaluation of Section 4(f) resources is provided in Chapter 8, *Section 4(f) Evaluation*, of this EA.

Section 2.6.3, *Section 106 Consultation Sessions*, of this EA discusses the Section 106 consultation process. The FTA has consulted with MHC, and the local historical commissions of Cambridge, Somerville, Medford, and Boston. These parties have concurred with the identification of historic resources. The FTA has also consulted with the Massachusetts Commission on Indian Affairs, the Mashpee Wampanoag Tribe and the Wampanoag Tribe of Gayhead/Aquinnah on potentially sensitive archeological resources.

### 5.15.1 Methodology

A cultural resources study was completed to identify known historic and archeological resources within the Green Line Extension project APE. The study also provided recommendations regarding the locations of potential sensitivity for archeological resources and identified historic resources requiring additional intensive survey and/or significance evaluation. The study was comprised of archival research, field survey, and analysis.

An APE, in accordance with 36 CFR 800.16(d), is the area or areas within which an undertaking may directly, indirectly, or cumulatively cause changes in the character or use of historic properties (defined as resources listed or eligible for listing in the National Register of Historic Places [the National Register]), if any such properties exist there. In addition to the actual site of the undertaking, an APE also includes other areas where the undertaking could cause changes in land use, traffic patterns, or other aspects that could affect historic properties. Different project factors may produce more than one APE for a given undertaking. Factors with potential to cause changes are direct impacts from noise, vibration, visual (setting), traffic, air quality, and construction activities, as well as any indirect and cumulative effects.

The Green Line Extension project APE for historic resources is defined as a linear area extending approximately 125 feet from the proposed right-of-way or one assessor's lot width (whichever is greater) on either side of the proposed Medford and Union Square Branches, and 125 feet around the proposed station locations and maintenance and storage facility site (Figures 5.15-1 through 5.15-9). This area encompasses the direct APE, defined as the construction limits of the project, as well as the indirect APE. The APE extends out to encompass the boundaries of adjoining historic districts. Individual National Register listed or eligible properties outside the 125-foot area will not be affected and no assessment was done.

The Green Line Extension project APE for archeological resources is the direct APE where ground disturbances are planned for the construction of project elements. These elements include the active and inactive railroad right-of-way segments, new station locations, the new maintenance and storage facility, and any other ancillary work areas and land acquisitions identified as part of the alternatives refinement. There is no indirect APE for archeological resources.

Archival research included review of existing cultural resource inventories, reports, and collected information on previously documented archeological and historic resources in the project study area. These include the Inventory of the Historic and Archeological Assets of the Commonwealth, and State Register and National Register files maintained by the MHC as well as the files of the BLC. Other archival materials, including local histories, historic maps and photographs, and census data were collected to establish a historical context for the towns encompassing the project study area. Environmental, geotechnical, and utilities information was reviewed to establish environmental contexts and understand prior ground disturbance.

A field survey of the APE was conducted to identify historic resources and areas potentially sensitive for archeological resources. The historic resources survey included an initial driveover within the project study area to become familiar with the general character and number of historic resources within it, and a walkover of the entire length of both of the rail rights-of-way, including the proposed station locations. Field survey for archeological sensitivity was conducted for work areas outside the rights-of-way, including proposed station sites and anticipated land acquisitions to identify existing conditions of ground surface integrity, modern disturbances, and current environmental settings. Because of safety and access permit requirements, the existing conditions information for right-of-way work areas was obtained from digital photographs and field notes. The archeological survey was conducted under Massachusetts State Archeological Permit No. 3014.

The historic architectural resources analysis included applying the National Register Criteria for Evaluation in order to develop preliminary National Register eligibility recommendations as well as recommendations for further identification survey and for evaluation of the significance of cultural resources within the APE.

The National Register criteria established by the National Park Service state that, "the quality of significance in American history, architecture, archeology, engineering, and culture is present in districts, sites, buildings, structures, and objects that possess integrity of location, design, setting, materials, workmanship, feeling, and association, and:

- That are associated with events that have made a significant contribution to the broad patterns of our history; or
- That are associated with the lives of persons significant in our past; or

- That embody the distinctive characteristics of a type, period or method of construction, or that represent the work of a master, or that possess high artistic values, or that represent a significant and distinguishable entity whose components may lack individual distinction; or
- That have yielded, or may be likely to yield information important in history or prehistory."[39]

The archeological sensitivity assessment utilized information collected during the archival research and the walkover survey/existing conditions review to develop a predictive model of potential site types and their cultural and temporal affiliation. The development of predictive models for locating archeological resources has become an increasingly important aspect of cultural resource management planning. The predictive model considers various criteria to rank the potential for the project study corridor to contain archeological sites. The criteria are proximity of recorded and documented sites, local land use history, environmental data, and existing conditions. The project study corridor was stratified into zones of expected archeological sensitivity to determine which areas would be tested.

## 5.15.2 Historic Resources

The Green Line Extension APE is principally a linear corridor that spans dense, urban development over hilly terrain, along the railroad corridor from Cambridge, through Somerville to Medford. The southeast end of the APE, which extends parallel to Monsignor O'Brien Highway and then McGrath Highway, consists primarily of boxy, multi-story commercial and industrial structures constructed from the early to late twentieth century. The highway separates the rail corridor from residential neighborhoods to the south. Where the Medford Branch joins the MBTA Lowell Line alignment, the Option L maintenance and storage facility site extends east from the linear corridor. This area is within an industrial district comprised of mid to late twentieth century buildings and railroad yards. The majority of the balance of the APE is comprised of late nineteenth to early twentieth century residential neighborhoods with modest wood-frame, two- to three-story single and multi-family houses. The neighborhoods within the APE are adjacent to pockets of commercial development and small civic or institutional centers. The Tufts University Medford campus is near the north end of the APE on either side of Boston Avenue.

The historic districts and individual properties within the APE that are listed, or eligible for listing in the National Register are identified in Table 5.15-1. The locations of all districts and individual properties identified within the APE are shown on Figures 5.15-1 through 5.15-9. The MBTA Lowell Line and MBTA Fitchburg Line railroad corridors were assessed for their historical characteristics and evaluated for National Register listing potential. The following section presents a summary of the

39 United States Department of the Interior, National Park Service, *National Register Criteria for Evaluation.* Available at: www.nps.gov/nr/publications/bulletins

two railroad corridors followed by information about each of the historic resources that have been listed, determined eligible for listing, or are recommended eligible for listing in the National Register.

**Table 5.15-1 National Register Listed or Eligible Properties or Districts within the Area of Potential Effect**

| Property | Map ID[1] | Area or Address | Municipality | National Register Designation |
|---|---|---|---|---|
| **National Register Listed** | | | | |
| Charles River Basin Historic District | C | Charles River Basin | Cambridge | Listed |
| Somerville Multiple Resource Area Historic District | F | Various | Somerville | Listed |
| Samuel Ireland House | 68 | 117 Washington Street | Somerville | Listed |
| Central Library | 161-1 | 79 Highland Avenue | Somerville | Listed |
| Somerville City Hall | 162 | 93 Highland Avenue | Somerville | Listed |
| Susan Russell House | 195 | 58 Sycamore Street | Somerville | Listed |
| **National Register Eligible** | | | | |
| Central Hill Area Historic District | H | Highland Avenue Area | Somerville | Eligible3 |
| Gilman Square Historic District | I | Gilman Square | Somerville | Eligible3 |
| Stickney Subdivision Area Historic District | J | Dartmouth Street Area | Somerville | Eligible3 |
| Powder House/Winter Hill Industrial Area Historic District | K | Vernon Street Area | Somerville | Eligible3 |
| Lechmere Viaduct | 1 | East Cambridge | Boston and Cambridge | Eligible2 |
| MBTA Lechmere Station | 2 | Lechmere Square | Cambridge | Eligible[3] |
| William L. Lockhart Coffin Factory Office | 11 | 199-201 Monsignor O'Brien Highway | Cambridge | Eligible[2] |
| John Morrell and Company Branch House | 12 | 221 Monsignor O'Brien Highway | Cambridge | Eligible[3] |
| Whitehead Metal Products Company | 13 | 225 Monsignor O'Brien Highway | Cambridge | Eligible[3] |
| Jackson and Newton Company | 18 | 51 McGrath Highway | Somerville | Eligible[3] |
| Buddy's Truck Stop/Sawin's Diner | 69 | 113 Washington Street | Somerville | Eligible[3] |
| McGrath Highway/Route 28 Bridge over B&M Railroad | 105 | McGrath Highway | Somerville | Eligible[2] |
| Hill-Michie Company Auto Garage | 130 | 295-297 Medford Street | Somerville | Eligible[3] |
| Litchfield Block | 136 | 247-251 Pearl Street | Somerville | Eligible[3] |
| Malta Temple/Signet Commandery #188 | 137 | 339-343 Medford Street | Somerville | Eligible[3] |
| Reid and Murdock Co. Warehouse | 138 | 350 Medford Street | Somerville | Eligible[3] |
| Somerville High School & Superintendent's Office | 161-2 | 81 Highland Avenue | Somerville | Eligible[2] |
| Derby Desk Company | 206 | 20 Vernon Street | Somerville | Eligible[3] |
| Hillson Building | 280 | 693-701 Broadway | Somerville | Eligible[3] |
| Somerville Automobile Company | 288 | 664 Boston Avenue | Medford | Eligible[3] |
| Warner & Childs Division Factory Mill and Garage | 302<br>302.1<br>302.1 | 546-574 Boston Avenue | Medford | Eligible[3] |
| Tufts University, Bray Memorial Laboratory | 305 | 504 Boston Avenue | Medford | Eligible[3] |
| Tufts University, Commons Building/Curtis Hall | 307 | 474 Boston Avenue | Medford | Eligible[3] |

Note: Resources are sequences south to north along the project corridor.
1 Number identifier indicates individual historic properties and letter identifier indicate historic districts.
2 Previously determined National Register-eligible by MHC.
3 Determined National Register-eligible as part of the Green Line Extension Study.

## National Register Listed Properties or Districts

Six properties or districts within the APE are listed on the National Register.

### Charles River Basin Historic District, Cambridge

The Charles River Basin Historic District (Figure 5.15-1, Map ID C) encompasses the parkways, park reservations, canals, dams, bridges, and other infrastructure constructed along the Charles River in Boston and Cambridge during the late nineteenth and early twentieth centuries. The Charles River Basin was improved and incorporated into Boston's metropolitan park system in an effort to maximize land use along the shoreline. The east end of the Charles River Basin Historic District is immediately south of the origin of the Green Line Extension APE at Monsignor O'Brien Highway and Lechmere Station. One contributing resource within the Charles River Basin, the Lechmere Viaduct (Map ID 1), is within the Green Line Extension APE and has been determined eligible for individual National Register listing.

### Somerville Multiple Resource Area Historic District

The City of Somerville Multiple Resource Area (Somerville MRA) (Figures 5-15-4 through 5.15-6, Map ID F) includes four historic districts and 79 individually listed properties throughout the City of Somerville. The Somerville MRA is a collection of primarily residential, modest examples of architectural styles prevalent in Somerville during major periods of development from the early eighteenth to the early twentieth century. Three properties individually listed in the National Register as part of the Somerville MRA are within the Green Line Extension APE, as summarized below.

### Samuel Ireland House, 117 Washington Street, Somerville

The Samuel Ireland House (Figure 5.15-4, Map ID 68) is approximately 100 feet northwest of an open, paved area that is part of the MBTA Lowell Line right-of-way. The house was initially inventoried by MHC in 1986 and dated to circa 1792, based on deed research. The MHC evaluated the building as eligible for National Register listing at the local level under Criterion C, for its significance as the only known eighteenth-century residence in the Cobble Hill neighborhood of Somerville. The Samuel Ireland House was designated as a Somerville Local Historic District in 1985 and was individually listed in the National Register as part of the Somerville MRA in 1989.

### Central Library, 79 Highland Street, Somerville

The Central Library (Figure 5.15-5, Map ID 161-1) is on a hill at the west corner of Walnut and Medford streets. The northeast boundary of the property borders the Green Line Extension project APE. The library is a two-story, rectangular, nine-bay by five-bay, Renaissance Revival building designed by Edward Lippincott Tilton and erected in 1914. It has a near-flat hip roof with green pan tiles, yellow brick walls, and limestone trim. Each elevation is horizontally divided by Classical limestone band courses and cornices with layered bands of molding and ornamental motif panels. The main entrance is centered on the south elevation and is marked by an elaborate, shallow portico consisting of a flat door hood with a terra cotta shield on top, and two Doric columns. The Central Library was listed in the National Register as a physical expression of the construction of grand civic amenities in the early twentieth century in the Renaissance Revival Style, designed by an architect influenced by McKim, Mead, and White, and the Ecole des Beaux Arts.

### City Hall, 93 Highland Avenue, Somerville

The Somerville City Hall (Figure 5.15-5, Map IDs 162) is at the east corner of Highland Avenue and School Street. The building is within a civic complex on Central Hill above the MBTA Lowell Line right-of-way, but only the northeast (side) elevation of the building is visible from the railroad. The main block was constructed in 1852 as the first Somerville High School. The building was converted to the City Hall in 1872 and the southwest wing was added in 1896 and expanded again in 1924. City Hall is a local example of a prominent civic building designed in the Classical Revival style. The building is individually listed in the National Register in the Somerville MRA (MHC No. SMV.AY) and is within the Central Hill Area (MHC No. SMV.C).

### Susan Russell House, 58 Sycamore Street, Somerville

The Susan Russell House (Figure 5.15-6, Map ID 195) is adjacent to the MBTA Lowell Line right-of-way and faces southeast toward Sycamore Street. The building is individually listed in the National Register in the Somerville MRA (MHC No. SMV.AY) as a well preserved, intact, local example of a Greek Revival-style, single-family house.

## National Register Eligible Properties or Districts

Twenty-three properties or districts were not on the National Register but were determined to be eligible for listing.

### Central Hill Area Historic District, Somerville

The Central Hill Area (Figures 5.15-4 through 5.15-6, Map ID H) is along the north and south side of Highland Avenue between Central and Hamlet streets. The north boundary of the Central Hill Area meets the Green Line Extension project APE near Gilman Square. The Central Hill Area is a linear, high-traffic corridor consisting of nine two- to four-story, late nineteenth- and early twentieth-century residential and institutional buildings, designed in the Queen Anne, Romanesque Revival, Renaissance Revival, and Colonial Revival styles; and one Greek Revival single-family residence. The area encompasses three National or State Register listed properties, including the Central Library, the Somerville City Hall, and the Fuller and Clark Apartment Houses. The Somerville High School and Superintendent's

Office was determined eligible for National Register listing. The area is eligible as a National Register District for its historic associations with the institutional development of Somerville and for its representation of large-scale late nineteenth through early twentieth century architecture.

### Gilman Square Area Historic District, Somerville

The Gilman Square Area (Figure 5.15-5, Map ID I) is at the intersection of Medford, Marshall, and Pearl Streets. This area contains four multi-story brick commercial and industrial buildings constructed between approximately 1887 and 1930. Gilman Square developed in the late nineteenth century as one of two competing commercial centers in Somerville, along the former Boston and Lowell (B&L, later B&M) Railroad. The MBTA Lowell Line abuts the southwest edge of the Gilman Square Area.

Although a few of the original buildings in Gilman Square are not extant, the area is eligible for listing in the National Register at the local level under Criteria A and C for its historical associations with the commercial development of Somerville and as a collection of intact building types that are not common in the Central Hill neighborhood. Three contributing resources in the area (Malta Temple/Signet Commandery No. 188 at 339-343 Medford Street, Reid and Murdock Company Warehouse at 350 Medford Street, and Litchfield Block at 247-251 Pearl Street) are all also individually eligible, and are included within the Green Line Extension project APE.

### Stickney Subdivision Area Historic District, Somerville

The Stickney Subdivision Area (Figure 5.15-5, Map ID J) is an approximately six-block neighborhood that encompasses both sides of School, Dartmouth, and Thurston Streets between Broadway and Medford Street in Somerville. The east corner of the Stickney area meets the edge of the Green Line Extension APE at Gilman Square. The Stickney subdivision was platted in 1883 and developed with 2.5-story, wood-frame, Queen Anne and Colonial Revival houses constructed between approximately 1885 and 1910. The majority of the houses were constructed and inhabited by Boston businessmen. Two properties (Map Nos. 142 and 144) within the area are within the Green Line Extension APE. The area is eligible as a National Register Historic District at the local level under Criteria A and C for its associations with the development of Somerville as a commuter suburb and as an intact neighborhood of late nineteenth and early twentieth century residential architecture.

### Powder House/Winter Hill Industrial Area Historic District, Somerville

The Powder House/Winter Hill Industrial Area (Figures 5.15-6 and 5.15-7, Map ID K) is north and south of the MBTA Lowell Line at the now abandoned junction of the B&L Railroad with the Fitchburg Freight Cut-Off in Somerville. This linear district contains a concentration of late nineteenth and early twentieth century industrial complexes associated with some of Somerville's historic manufacturing specialties, including baked goods, paper products, and wood furniture and architectural trim. Three contributing resources in the area, the Derby Desk Company at 20 Vernon Street, Agar Manufacturing Co. at 55 Clyde Street, and Carlisle-Ayer Company at 50 Clyde Street, are included within the Green Line Extension project APE. The district is eligible for the National Register at the local level under Criteria A and C. The Derby Desk Company is individually eligible.

### Lechmere Viaduct, Cambridge and Boston

The Lechmere Viaduct (also known as the East Cambridge Viaduct) (Figure 5.15-1, Map ID 1) was erected from 1910 to 1911 to carry street car rail tracks over the river. The Viaduct consists of three elements: a ten-span concrete arch bridge incorporating a steel trunnion bascule, a steel elevated section in Boston, and a steel elevated section in Cambridge. The concrete portion of the Viaduct with its attendant bascule span was listed as a contributing resource in the Charles River Basin Historic District described above. This portion of the viaduct was also surveyed in 1984 and determined individually eligible for National Register listing in 1985. The steel elevated section of the viaduct in Cambridge was recommended as eligible for listing in the National Register in 2004. This portion of the viaduct extends within the construction limits of the Green Line Extension project. The steel elevated section in Boston under the MBTA Science Park Station was recommended as eligible for listing in the National Register in 2007. The entire Viaduct is individually eligible for the National Register under Criteria A and C at the local level.

### Lechmere Station, Lechmere Square at Cambridge and Gore Street, Cambridge

Existing Lechmere Station (Figure 5.15-1, Map ID 2) is an MBTA Green Line complex in Cambridge between Monsignor O’Brien Highway (Bridge Street/Route 28) and Cambridge Street. The station is at the north end of the Lechmere Viaduct, which carries the Green Line across the Charles River. The station was opened July 10, 1922 as a transfer point between street cars from Cambridge and Somerville and the Tremont Street Subway. The station continues to serve in its intended capacity today, but as the northern terminus of the current Green Line subway. The station’s construction and design as a transfer point was an important step in the rationalization of Tremont Street Subway operations and has continued to serve as a critical operations point to the present day. The station platforms are rare surviving early twentieth century street rail shelters. The bus shelter is eligible as part of the complex and, in conjunction with the original platforms, is illustrative of changing approaches to mass transit shelter construction. The station complex is eligible under Criteria A and C at the local level.

### William L. Lockhart Coffin Factory Office, 201 Monsignor O’Brien Highway, Cambridge

The William L. Lockhart Coffin Factory Office (Figure 5.15-1, Map ID 11) is on Monsignor O’Brien Highway in the William L. Lockhart Factory Area. The north boundary of the property borders the Green Line Extension project APE. The factory office is a four-story, irregular plan, nine-bay by five-bay, Second Empire style building constructed circa 1868–1873. It has a flat roof with a shallow Mansard roof on the facade, slate shingles and red brick walls. The main entrance is on the west end of the façade with eight single-pane, fixed, full-height windows. The first and second stories are separated horizontally divided by a denticulated brick band course. The William L. Lockhart Coffin Factory Office was determined eligible for the National Register in 1989 for its associations with the Lockhart Coffin Company and manufacturing in Cambridge during the period and as a rare surviving example of late nineteenth century industrial architecture in Cambridge.

### John Morrell & Company, 221 Monsignor O'Brien Highway, Cambridge

The John Morrell & Company Building (Figure 5.15-1, Map ID 12) is a reinforced concrete, Georgian Revival-style intermodal warehouse with brick curtain walls built in 1929 fronting Monsignor O'Brien Highway (Route 28). The building was constructed as a wholesale meat distribution center. The building was designed by the architectural firm of Henschein and McLaren of Chicago. The property is currently vacant and condemned. John Morrell & Company, now part of processed meat producer Smithfield Foods, Inc., the oldest continually operating meat manufacturer in the United States. Founded in 1827, company was historically based in Ottumwa, Iowa and specialized in pork packaging and shipping. Branch distribution warehouses were in Boston and New York. Between 1982 and 1991, the company was one of the top-ranking meat and poultry companies as measured by net sales. The building is eligible for the National Register under Criterion A because of its relationship to the meat packing trade of greater Boston, an important regional late nineteenth and early twentieth century industry, and under Criterion C because of its unique Classical Revival treatment as applied to a local distribution warehouse.

### Whitehead Metal Products Company, 225 Monsignor O'Brien Highway, Cambridge

The Whitehead Metal Products Company building (Figure 5.15-1, Map ID 13) is an Art Deco-style loft and warehouse, four stories tall and five-by-seven bays in plan. The Whitehead Metal Products building was constructed in 1929 with design services by M.A. Reidy and John H. Spiers. Whitehead Metal Products was a New York-based firm that manufactured and distributed sheet metal, rod and wire, pipes, valves, and fittings. Around 1950, the building was taken over by the Jordan Marsh Company as a warehouse. Superior Nut Company currently occupies the building. The Whitehead Metal Products Company warehouse is eligible for the National Register under Criterion C because of its distinguished Art Deco decorative treatment as applied to a warehouse structure. Although the building's fenestration has been covered and/or altered, the structure retains all of its character-defining massing and Art Deco trim elements.

### Jackson and Newton Company, 51 McGrath Highway/Route 28, Somerville

The Jackson and Newton Company building (Figure 5.15-2, Map ID 18) is a three-story, twelve-bay-by twenty-four-bay mill loft. The Jackson and Newton Company building was built between 1900 and 1908 for the manufacture of doors, sashes, and blinds. The company was owned by Frederick H. Newton of West Roxbury, who operated a second architectural trim company in West Somerville. The firm operated until circa 1927, when it merged with Brockaway-Smith and a third company to form the Brockaway-Smith-Haigh-Lovell Company (now Brosco), which continues to operate as a wholesale distributor of building products. The building was vacant from that year until 1933, when it was occupied by a furniture manufacturer and radiator company. The building appears to be partially unoccupied.

The Jackson and Newton Company building was surveyed in 1990 as part of the *Somerville Industrial and Commercial Survey* and recommended eligible for the National Register under Criterion C as "a very well-preserved representative or early twentieth century brick and granite industrial architecture." Although the building has been partially rehabilitated since this recommendation, it still appears eligible for the National Register under Criterion C because is retains the majority of its character-defining elements. The building is eligible for the National Register under Criterion A because of its association with the building trades industry of Somerville in the late industrial period.

### Buddy's Truck Stop/Sawin's Diner, 113 Washington Street, Somerville

Buddy's Truck Stop (Figure 5.15-4, Map ID 69) is approximately 100 feet northwest of an open, paved area that is part of the MBTA Lowell Line right-of-way. The structure is a one-story diner constructed in 1929 by the Worcester Lunch Car Company for a location in Leominster, Massachusetts, where it was known as Sawin's Diner. The diner was moved to its current location in 1951. Buddy's Truck Stop was designated as a Local Historic District in 1989. It was considered but not included in the *Diners of Massachusetts National Register Multiple Property Submission* completed in 1999. In 2005, Buddy's Truck Stop was determined individually eligible for National Register listing under Criterion C as a rare local example of an early twentieth century diner.

### McGrath Highway/Route 28 Bridge over B&M Railroad, Somerville

The McGrath Highway/Route 28 Bridge (Figure 5.15-4, Map ID 105) over the MBTA Lowell Line (formerly the B&M Railroad) is a double-barreled (three truss panels creating two roadways), riveted, Parker/Camelback through truss bridge. The skewed, 162-foot span structure carries the McGrath Highway/Route 28 (formerly the Northern Traffic Artery) on a north-south course over the southeast-northwest trending, multi-track earthen cut of the former B&M Railroad. The bridge was erected as part of highway construction in 1926 by the Boston Bridge Works, which followed designs provided by the Metropolitan District Commission. The bridge was rehabilitated in 1983. The MHC determined that the bridge was eligible for the

National Register in 1987 as the only known example of the camelback truss type in Massachusetts.

### Hill-Michie Company Auto Garage, 295-97 Medford Street, Somerville

The Hill-Michie Company Auto Garage (Figure 5.15-5, Map ID 130) is at the east corner of Walnut and Medford Streets on a sloping lot bordered by the MBTA Lowell Line on the northeast (rear) side. The garage is a one-story, brick commercial building constructed in 1906 and designed by Frank H. Dillaby of Boston. The garage is eligible for the National Register at the local level under Criteria A and C for association with the development of automobile commercial services in the city and as a well-preserved example of early twentieth century brick garage construction. The building is likely the oldest auto garage and car dealership in Somerville.

### Litchfield Block, 247-251 Pearl Street, Somerville

The Litchfield Block (Figure 5.15-5, Map ID 136) is at the corner of Pearl and Marshall streets in Gilman Square on the north side of the Green Line Extension APE. The building is a four-story, seven-bay by eight-bay, rectangular building constructed in 1891. It has a flat roof, red brick walls, a brick parapet, and brownstone trim. Pairs of second and third story windows are capped with brownstone lintels or splayed brick arches. The third story has single windows. Three first story storefronts have recessed doorways and altered windows. A brick relief nameplate, which reads "Litchfield Block," is between the second and third stories of the facade. The Litchfield Block is eligible for the National Register at the local level under Criterion C for its representation of late nineteenth century commercial architecture in Somerville.

### Malta Temple/Signet Commandery #188, 339-343 Medford Street, Somerville

The Malta Temple/Signet Commandery #188 (Figure 5.15-5, Map ID 137) is at the corner of Medford and Pearl streets in Gilman Square. The property is north of the Green Line Extension APE. The building is a three-and-one-half-story, nearly triangular, Classical Revival building constructed in 1902. It has a flat roof, orange brick walls, and brownstone, terracotta, and copper trim. The facade is visually divided into three equal bays with a narrower fourth bay at one end. The central bay has a gable pediment and three, two-story, segmental arches. Three copper cast relief panels are beneath the gable pediment. The main entrance is at the southwest corner of the building with a large copper relief panel above the recessed opening. The first story storefront windows have been filled with brick. The first and second stories are separated by a projecting band course. The Malta Temple/Signet Commandery #188 is eligible for National Register listing at the local level under Criterion A for its association with the development of Gilman Square between the late nineteenth and early twentieth centuries and under Criterion C as a surviving example of a social hall with commercial space, a common building type in Somerville in the nineteenth century.

### Reid and Murdock Company Warehouse, 350 Medford Street, Somerville

The Reid and Murdock Company Warehouse (Figure 5.15-5, Map ID 138) is at the corner of Medford and School streets, bounded on the south by the MBTA Lowell Line. The building is a three-story, nine-bay by four-bay, brick loft with austere Art Deco detailing constructed in 1929. The flat roof has a parapet with projecting geometric concrete crockets. Brick piers with corbelled capitals and concrete panels divide the elevations into equal-width bays. The two bays on the northwest end of the facade are part of a historic addition. The facade's center entrance has an elaborate concrete entablature with a lion's head (a company emblem) and projecting finials in relief. An original, three-bay loading dock is on the southeast elevation. The rear (south) elevation retains a railway loading dock with a steel awning. Both the truck loading dock on the northwest elevation and the metal clad addition on the south (rear/trackside addition) are generic light industrial structures that are less than 50 years old. The building is eligible for the National Register at the local level under Criterion A for its associations with the Somerville wholesale foods industry and under Criterion C as a well preserved example of early twentieth century industrial design.

### Somerville High School, 81 Highland Avenue, Somerville

The Somerville High School (Figure 5.15-5, Map ID 161-2) faces Highland Avenue within the Central Hill Area (SMV.C), but its northeast (rear) elevation overlooks a steep slope toward the MBTA Lowell Line and proposed Gilman Square Station. The first building on the site is incorporated into the current central block of the complex. In 1895, the Somerville English High School was constructed. Two more three-story wings on either side of the central building (called the east and west wings), and a connected two-story auditorium wing were added to the school in 1928, constructed of the same materials and in the same style as the central building. The Somerville High School was determined National Register eligible by MHC in 1982 as the "center of a significant institutional complex," including the adjacent Somerville City Hall (MHC No. SMV.37) and Somerville Library (MHC No. SMV.66).

### Derby Desk Company, 20 Vernon Street, Somerville

The Derby Desk Company (Figure 5.15-6, Map ID 206) is at the corner of Vernon and Central streets and is bounded on the south by the MBTA Lowell Line. The complex consists of two main buildings. The main factory along Vernon Street is a six-story, 26-bay by six-bay, rectangular building constructed in 1887. It has a flat roof, red brick walls, and brick piers vertically dividing each bay. A corbelled brick cornice is set in between each pier on the sixth story. A seven-story, flat-roofed, rectangular, brick stair and elevator tower with a corbelled brick cornice is on the south elevation of the main factory building. The secondary mill is at the corner of Vernon and Central Streets. It is a three-story, eight-bay by seventeen-bay, rectangular building constructed circa 1895 to 1897. Central Street slopes down toward the railroad providing for a fourth story on the rear elevation. It has a flat roof, red brick walls, and vertical piers vertically dividing each bay. A corbelled brick cornice is set in between each pier on the third story. A two-story addition west corner of the complex connects the main factory and the mill. The Derby Desk Company is individually eligible for the National Register for its associations with the woodworking manufacturing industry and representation of early twentieth century industrial architecture.

### Hillson Building, 693-701 Broadway, 651 Boston Avenue, Somerville

The Hillson Building (Figure 5.15-7, Map ID 280) is approximately 50 feet west of the proposed Ball Square Station. The building is a two-story, Classical Revival style commercial block completed in 1925. The building is eligible for National Register listing at the local level under Criterion C, as a rare example of a Beaux Arts style commercial block in Somerville.

### Somerville Automobile Company, 662-664 Boston Avenue, Medford and Somerville

The Somerville Automobile Company in Medford and Somerville (Figure 5.15-7, Map ID 288) fronts Boston Avenue at the intersection of Boston Avenue and Broadway in Ball Square. The complex occupies two parcels that are transected by the Medford-Somerville corporate boundary. The garage complex consists of two one-story, end-gable, light industrial garage buildings connected by a one-story hyphen. The garage was established on Boston Avenue in 1906 with the two iron garage buildings and connecting hyphen that are retained today. Like other early car-related facilities, the Somerville Automobile Company sold automobiles and also offered parking garage and repairing facilities. A 1912 photograph of the garage complex indicates that the property retains its overall massing, materials, and workmanship. The Somerville Automobile Company complex is eligible for National Register listing under Criterion A at the local level for its associations with automobile transportation in Medford and Somerville.

### Warner & Childs Division Factory Mill & Garage, 574 Boston Avenue, Medford

The Warner & Childs Division Factory complex (Figure 5.15-8, Map IDs 302/302.1) in Medford abuts the MBTA Lowell Line at the corner of Boston Avenue and Harvard Street. The complex consists of two reinforced concrete pier-and-spandrel buildings with flat roofs: a four-story, fourteen-bay-by-six-bay manufacturing loft with an attached Boiler Room and brick stack and a one-story garage (Map ID 303). The mill complex was constructed in 1919 by the Robert Gair Company, an umbrella organization that included the Warner & Childs Division. The mill complex is one of three early twentieth century corrugated paper box factories within the project APE on the MBTA Lowell Line (see also Agar Manufacturing [Map ID 226], listed in the Powder House/Winter Hill Industrial Area above). Box manufacturers were a supporting industry for the intermodal distribution facilities that were established in Cambridge and Somerville during the same time period.

The Warner & Childs Mill complex is eligible for the National Register under Criterion A because of its association with the rail freight distribution and paper industries in the Cambridge-Somerville-Medford area, its association with the Robert Gair Company, and under Criterion C as an excellent representative example of early twentieth century reinforced concrete loft construction.

#### Tufts University, Bray Memorial Laboratory of Mechanical Engineering, 504 Boston Avenue, Medford

The Tufts University Bray Memorial Laboratory of Mechanical Engineering (Figure 5.15-8, Map ID 305) is between Boston Avenue and the MBTA Lowell Line, which is parallel to the northeast (rear) side of the building. Bray Laboratory is a two-story, 13-bay by three-bay, rectangular, Modern style building constructed in 1947 as part of Tufts University's Medford campus. The Bray Laboratory building is eligible for National Register listing at the local level, under Criteria A and C as an intact example of a Modern institutional building and for its historic use as a Navy test laboratory.

#### Tufts University, Commons Building/Curtis Hall, 474 Boston Avenue, Medford

The Tufts University Commons Building/Curtis Hall (Figure 5.15-8, Map ID 307) faces west toward the intersection of Boston Avenue and College Avenue and is adjacent to the MBTA Lowell Line, which is to the east (rear) of the building. Curtis Hall is a Renaissance Revival-style mess hall and student center constructed in 1893 with a three-story central block flanked by side wings. Curtis Hall was designed by George A. Clough, who served as the architect for several other buildings on the Tufts campus. The building has been continually used for mixed-use student purposes since its construction. Such uses included a dining hall, post office, store, dormitory above the first story, and a conference room. The dining hall was used by the Student Army Training Corps during World War I and the Navy during World War II. Curtis Hall is eligible for a National Register listing at the local level under Criteria A and C as an example of the Renaissance Revival style as designed by George A. Clough and for its continual use as a primary Tufts University community building.

### 5.15.3 Archeological Resources

There are no previously recorded pre-contact period archeological sites within the Green Line project APE for archeological resources. The pre-contact/contact period estuarine environment of the Mystic and Charles Rivers and Boston Harbor would have been highly conducive for Native American subsistence activities and settlement. It is generally expected that portions of the project APE could possibly contain intact pre-contact/contact period archeological deposits such as shell resource processing/middens, fish weirs, and seasonal encampments. According to MHC site files, one such resource area, a pre-contact period shell midden (19-MD-171), was identified in 1968 near the tip of Lechmere's Point, about 0.5 miles to the north and east of Lechmere Station.

The Green Line Extension project study corridor and the surrounding land have experienced large-scale and widespread post-contact period earthmoving activities. The most prominent disturbance factors include extensive filling and/or cutting for the existing rail line. It is therefore expected that the degree of post-contact period disturbances have substantially decreased the likelihood of encountering intact pre-contact/contact period archeological deposits in the majority of the APE.

There is one recorded historic site immediately adjacent (south side) to the MBTA Fitchburg Line right-of-way in Somerville. It consists of the Union Glass Works (SMV-HA-1), a mid nineteenth thru early twentieth century industrial complex.

It can be generally expected that evidence of recorded sites as well as additional documented resources based on historical maps and underdocumented resources from the seventeenth century through the early twentieth century could be present in belowground strata within sensitive sections of the APE. Resource types could range from residential (early farmsteads to urban dwellings), commercial, industrial, and transportation-related resources both in terrestrial and riverine environments. As with the pre-contact/contact period site potential, it is expected that the degree of modern period (twentieth century and ongoing) disturbances would substantially decrease the likelihood of encountering intact historic period archeological deposits in the majority of the APE.

The project team has recently relocated the Washington Street Station (formerly known as Brickbottom Station) to avoid potential impact to archeologically sensitive strata between Joy Street and the railroad right-of-way in Somerville known to previously contain mid to late nineteenth century worker housing.

Based on a recent review of soil borings, MHC determined no further archeological survey is warranted in the proposed Option L maintenance and storage facility location, due to lack of evidence of Native American land use/occupation and previously disturbed belowground soil contexts. This location was previously identified as an area of potential archeologically sensitivity.

No other areas of archeological sensitivity were identified for the Green Line project APE because of the presence of extensive fill and/or previously disturbed belowground soil contexts.

## 5.16 Hazardous Materials and Solid Waste

This section discusses the potential presence of oil or hazardous materials (OHM) and solid waste on or adjacent to the proposed station locations for the proposed Green Line Extension project.

To assess the potential for encountering OHM, Phase I Environmental Site Assessments (ESAs) were performed as per the American Society for Testing Materials (ASTM) 1527-05 Standard and All Appropriate Inquiry (AAI) pursuant to 40 CFR Part 312. The purpose of the Phase I ESAs is to identify Recognized Environmental Conditions (RECs) in connection with the properties, to the extent feasible pursuant to the process described in the Standard. The scope of the Phase I ESAs included:

- Performing a database search of Federal and state files. The Federal databases included the current Comprehensive Environmental Response, Compensation and Liability Information System (CERCLIS), National Priorities List (NPL), Resource Conservation and Recovery Act (RCRA) Transportation, Storage and Disposal (TSD), RCRA Generators, and Emergency Response Notification System (ERNS) list. The state databases included the state equivalent CERCLIS list, spills, Underground Storage Tanks (UST), Solid Waste Landfills (SWL), and public water supply lists.
- As necessary, reviewing available MassDEP files to provide more information about reported releases of OHM identified through the database search on or adjacent to the site. The MassDEP files provided additional information regarding past ownership; historic site usage; past usage, storage and disposal of OHM on and adjacent to the proposed station sites; and other evidence of potential environmental impacts.
- Reviewing available municipal and historic files to help confirm ownership history and past usage. Resources included tax records, aerial photographs, Board of Health Department records, Building Department records, Fire Department records, Conservation Commission records, and Sanborn fire insurance maps. The site history review also identified reports of historic spills, disposal areas, or other past releases of OHM on or adjacent to the project study corridor.
- Reviewing previous site documents including an ESA, if applicable and/or available for review.
- Performing a site reconnaissance to observe sites for overt evidence of a release or threat of release of oil and/or hazardous materials within interior and exterior portions of the entire property. The uses of abutting properties were also documented.

Areas of property acquisition were also assessed as discussed above. Properties already owned by the MBTA or the Commonwealth of Massachusetts were not assessed. Potential environmental concerns or *de minimis* conditions have been identified at the majority of the station sites since asbestos-containing materials (including roof flashing, tiles, and other materials), as well as lead-based paint may be present.

### 5.16.1 Lechmere Station, Cambridge

For this station, the MBTA Water Street Garage property at 21 Water Street in Cambridge (Release Tracking Numbers [RTNs] 3-18502 and 3-26115) was assessed due to known contamination issues near the proposed relocated Lechmere Station. Documents reviewed included:

- The March 2004 Phase II Comprehensive Site Assessment Report and Phase III Remedial Action Plan prepared by Weston and Sampson;
- The December 28, 2007 Immediate Response Action (IRA) Completion Statement prepared by ATC Associates; and
- The August 8, 2008 Phase IV Status Report No. 7 prepared by ATC Associates.

This property, which comprises 2.5 acres, has been developed with a two-story concrete block garage used by the MBTA that includes a tool shop and storage area. The garage is on the northern portion of the property. Abandoned railroad tracks are on the southern portion of the property. A pad-mounted electrical transformer is on the western end of the property and a storage shed is on the eastern portion. The remaining property consists of an asphalt paved parking area.

A historic release of gasoline and fuel oil from USTs into soil and groundwater resulted in a release notification form being submitted to the MassDEP on July 2, 1999. RTN 3-18502 was assigned to the release. Remedial actions have consisted of the removal of approximately six tons of petroleum-contaminated soil. RTN 3-26155 was assigned to the site in August 17, 2007 when a 4,000-gallon gasoline UST failed a tightness test, resulting in a 72-hour reporting condition to the MassDEP. The UST was subsequently removed; no contaminated soil was encountered. The failed tightness test was deemed to be attributed to the associated piping. The two RTNs were subsequently linked to one RTN (3-18502).

Groundwater monitoring wells installed throughout at the site showed the existence of gasoline-related compounds above the applicable regulatory standards as per the Massachusetts Contingency Plan (MCP). The remedial technology chosen in the Phase III Remedial Action Plan is monitored natural attenuation. During the May 2008 sampling round, only xylene was detected in four monitoring wells above the regulatory standards. The proposed station is located several hundred feet southeast of this site. The groundwater flow from the site is to the south-southwest;

therefore, impacted groundwater from this site would not likely impact the proposed station.

## 5.16.2 Option L Maintenance and Storage Facility Site, Somerville

Based upon the tasks conducted for the Phase I ESA, seven RECs associated with the proposed Option L maintenance and storage facility site were identified.

### Historic Use of Site as Railroad Yard

Historic aerial photographs and Sanborn fire insurance maps show the site as previously encompassing a network of railroad tracks from the early to mid 1990s. Historic rail yards are typically sources of OHM, including metals and semi-volatile organic compounds (SVOC). Urban fill, which can contain metals andPAHs, may have also been placed on the site in order to bring tracks to grade or fill in wetland areas. Therefore, soil and groundwater may be impacted by these contaminants, which could particularly affect soil export costs, and is considered a REC.

### Use of 48 Third Avenue as a Printing Facility

According to the Environmental Data Resources, Inc. (EDR) City Directory Abstract and Somerville Building Department files, the property at 48 Third Avenue has been occupied by a graphics/printing company since at least the 1980s. Printing facilities can generate chemical solutions and inks that in some cases are classified as hazardous waste. Health Department files from 1996 indicate that a Solid Waste Distillation System for recycling petroleum constituents and distillates was at one point used at the property, which would likely generate hazardous waste that may or may not have been properly disposed of after treatment. Several small quantity generator and air pollution violations were also noted by MassDEP at the property, and notices of noncompliance were issued in January 1994, December 2001, and March 2002. In addition, Somerville Fire Department records indicate that the current tenant, Universal Millennium Printing Co., has been permitted for hydraulic oil, machine oil, solvents, film cleaner and small amounts of petroleum products. The potential exists for these chemicals to have been improperly disposed and to have impacted soil and groundwater at the property and is considered a REC.

### Release of Petroleum at 100 Inner Belt Road and Petroleum Storage at 70 Inner Belt Road

A disposal site at 100 Inner Belt Road (currently 70 Inner Belt Road) was assigned RTN 3-974 in January 1988 for a release of petroleum and arsenic. The property at 100 Inner Belt Road was combined with 70 Inner Belt Road in 2008. The disposal site associated with RTN 3-974 achieved a Class B-2 Response Action Outcome (RAO) in February 2002, indicating that response actions were not performed, and a Condition of No Significant Risk relies on the implementation of one or more Activity and Use Limitations (AUL). The AUL area encompasses the parking lot south of the building at 70 Inner Belt Road. In addition, 70 Inner Belt Road is licensed by the Somerville Fire Department for at least 11,500 gallons of diesel fuel stored aboveground at the property for five emergency generators. The presence of an AUL on the site formerly designated as 100 Inner Belt Road, and the storage of large quantities of diesel fuel abutting the proposed area of taking at 70 Inner Belt Road is considered a REC.

### Former Condition of 150-200 Inner Belt Road

In a letter dated February 16, 2000 prepared by the City of Somerville Zoning Planning Board and addressed to the Zoning Board of Appeals, this property's condition was described as "in deplorable condition, as it has been a salvage yard and dumping ground for years." The property was developed later in 2000 with two 100,000-square foot buildings for Internet switching facilities and office space. The poor housekeeping practices described in the letter suggests that OHM may have been present at the property and is considered a REC as it is unknown if OHM releases occurred.

### Release of Arsenic and PCBs at 120 Inner Belt Road

A disposal site at 120 Inner Belt Road was assigned RTN 3-19075 in December 1999 for a release of arsenic and PCBs. The disposal site achieved a Class B-1 Remedial Action Outcome in December 1999, indicating that response actions were not performed, and a Condition of No Significant Risk exists for the site. It is unknown whether 120 Inner Belt Road was at one time part of the site because the address is not listed in the Somerville Assessor's information. However, the property is conservatively assumed to be on or near the site due to the sequence of addresses associated with surrounding properties. Also, the nature of arsenic and PCB contamination at or near the site is likely due to pervasive contamination associated with urban fill throughout this area, and documented in response actions conducted at nearby properties. Therefore, the potential exists for these contaminants to have impacted soil and groundwater at this property and is considered a REC.

### Releases at Yard 8

In 1980, a release of 13,000 gallons of phosphorous trichloride occurred when a B&M Corporation locomotive collided with a standing draft of cars in Somerville Yard 8. Yard 8, according to a historical map prepared for the B&M Railroad in 1931, appears to be in the vicinity of 150-200 Inner Belt Road and encompasses portions of the site. A total of 23,000 people in a 1.5-square mile area were evacuated due to the release. Phosphorous trichloride is classified by the U.S. DOT as a hazardous material and corrosive liquid. The release was addressed by backfilling with sand and gradually adding water. This release was addressed prior to implementation of the MCP, and was not assigned a RTN.

In addition, RTN 3-4222 was assigned to a release of PCBs and petroleum at Yard 8 in January 1993. The disposal site achieved a Class B-1 RAO indicating that response actions were not performed, and a Condition of No Significant Risk exists for the site. Both releases are believed to have occurred on the site and are therefore considered a REC.

#### Releases at and current use of MBCR Maintenance Facility at 70R Third Avenue

The Massachusetts Bay Commuter Railroad Company (MBCR) maintenance facility at 70R Third Avenue was listed by the Somerville Fire Department with permits to maintain large quantities of fuel oil, waste oil, waste antifreeze, diesel, lube oil, engine coolant, and HEP oil. The storage, use, and/or generation of these products have resulted in a release of OHM. Several previous releases of petroleum products and their constituents have occurred at the property (N90-1956, N90-0236, N90-1810, N93-0627, N93-0705, RTN 3-24428, 3-22276, 3-26988, 3-22964, and 3-23114). Since contamination is pervasive in this area, there is a possibility that the contaminants from this property has migrated to the proposed Option L maintenance and storage facility site; therefore, these nearby releases documented on the adjacent MBCR property and the current use of the property as a commuter rail maintenance facility are considered a REC for the site.

### 5.16.3 Washington Street Station, Somerville

Based upon the tasks conducted in advance of a Phase I ESA, six RECs associated with the proposed Washington Street Station site were identified.

#### On-site Releases at 4 Joy Street

One of the properties comprising the site was assigned RTN 3-11444 on January 4, 1995 due to a release of waste oil discovered during the removal of a 1,000-gallon UST. During Interim Remedial Action (IRA) assessment activities in October 1995, over 2 feet of separate-phase product was measured in a monitoring well in the area of the former UST and the disposal site was assigned RTN 3-13082.

In January 2004, a second RTN 3-23562 was assigned to the disposal site due to the discovery of PCBs in the groundwater. Response actions at the disposal site have included removal of contaminated soil, and petroleum and PCB-contaminated groundwater, the installation of three recovery wells, and periodic pumping of product from the wells. A Class C-2 RAO Statement was submitted for the disposal site in August 2008. The RAO indicated that a Condition of No Substantial Hazard exists at the disposal site, and response actions to achieve a Permanent Solution are feasible and to be conducted. Soil beneath the current property building exceeds current regulatory thresholds for petroleum constituents; however, it is currently not feasible to remediate in this area. As of July 2010, separate phase PCB-containing hydraulic oil remains in measurable thickness at several monitoring wells. Soil and groundwater at the site have been impacted by this disposal site which is considered a REC.

### Petroleum Storage at the Site

The Somerville Fire Department has issued several permits to store petroleum products at 4 Joy Street. Beginning in 1961, two 55-gallon drums of grease, 220 gallons of transmission fluid, and 550 gallons of mineral spirits were permitted for the property. A permit from 1988 stated that a 550-gallon waste oil UST was in front of the building, and had been installed approximately 15 years prior. Records show that this waste oil UST was removed in July 1994. In addition, a tank removal permit from July 1994 for a 1,000-gallon waste oil UST was provided by the Fire Department. Finally, two 275-gallon waste oil ASTs were removed from the property in November 2003.

The current tenant has a permit to maintain one 55-gallon drum of transmission fluid, eight cases of washer fluid, 120 pounds of drum gear oil, and one 275-gallon tank for bulk oil. Although the removal of the above-mentioned 1,000-gallon UST resulted in a release assigned RTN 3-11444, sampling or field screening data was not provided for the removal of the 550-gallon waste oil tank in 1994. In addition, the storage of petroleum fluids on the property since 1961 indicates a potential for spills and leaks to enter surrounding soil and groundwater. Petroleum storage at the site is therefore considered a REC.

### Historic Use of the Site for Vehicle Repair and Maintenance

The site has been used for vehicle repair and maintenance as early as 1961, when a permit from the Somerville Fire Department for 4 Joy Street states "Hydromatic Sales & Service Corp." as the property tenant. Currently, Cataldo Ambulance's maintenance shop occupies the property. The property at 12 Joy Street was formerly a dwelling constructed in 1930, which was converted to Joy Street Auto Body in the 1980s. Automobile repair shops tend to use various petroleum-based fluids, and may include storage of these materials in drums, hydraulic lifts, or storage tanks. In addition, vehicles stored on the property have the potential to release small amounts of oil and/or hazardous materials into the environment. Finally, car batteries and other waste materials generated during maintenance activities have the potential to impact the surrounding soil and groundwater if not properly disposed. The current and historic use of the site for auto repair and maintenance is therefore considered a REC.

### Former Use of Adjacent Property (100-120 New Washington Street) for Petroleum Products Storage

According to historical Sanborn maps from 1930 and 1950, the property with an address of 100-120 New Washington Street, which is adjacent to the site across the railroad tracks, was once used as a filling station and the "American Oil Products Co." The maps shows several ASTs for oil stored on the property as well as a mixing building, likely used to blend various fuels. A release at the property was identified in 1998 and was assigned RTN 3-18503 for the detection of petroleum constituents in soil during the in-place decommissioning of a 5,000-gallon No. 2 fuel oil UST. The disposal site achieved a Class B-2 RAO, which indicates that a Condition of No Significant Risk was achieved without the need to conduct response actions. An AUL is currently in place at the property, which governs restrictions for current and potential property uses. Due to a lack of response actions necessary to achieve the Class B-2 RAO, as well as the presence of a decommissioned UST, and former history of petroleum products storage, the property has a potential to impact soil and groundwater at the site. Therefore, the former use of 100-120 New Washington Street is considered a REC.

### Release at Nearby Property near Yard 8

As described for the proposed Option L maintenance and storage facility site, in April 1980, a release of 13,000 gallons of phosphorous trichloride occurred when a B&M Corporation locomotive collided with a standing draft of cars in Somerville Yard 8. Yard 8, according to a historical map prepared for the B&M Railroad in 1931, appears to be in the vicinity of the site. A document provided by the Somerville Fire Department states "April 3, 1980: Chemical spill in the vicinity of 12-16 Joy St. from a railroad tank. Phosphorus trichloride (ID #1809). Spill contained in a pool at this location." Based on the indication from the Fire Department that this release may have impacted the site, the release is considered a REC.

### Off-site Release at 50 Tufts Street

A disposal site at 50 Tufts Street was assigned RTN 3-23246 in 2002 for a release of chlorinated solvents to soil and groundwater, which was later detected in indoor air on the property, and in groundwater and indoor air at residential and commercial properties in the vicinity of the disposal site. The property had been used for storage and distribution of industrial chemicals, laundry supplies, and dry cleaning supplies from 1955 to 2002. According to the IRA Status Report submitted to MassDEP for the disposal site in May 2009, a plume of chlorinated solvents, specifically tetrachloroethylene (also known as perchloroethylene, or PCE), has migrated in bedrock groundwater south and east of the disposal site, toward the site. In addition, a disposal site boundary is depicted in close proximity to the site. The disposal site at 50 Tufts Street is considered a REC.

### 5.16.4 Gilman Square Station, Somerville

Based upon the tasks conducted for the Phase I ESA, three RECs associated with the proposed Gilman Square Station site were identified.

#### Release at Somerville High School, 81 Highland Avenue

Approximately 1,000 gallons of fuel oil were released from a rupture of a boiler transfer supply pump pipe at the high school boiler room on December 26, 2006. The RTN 3-26487 was assigned. The boiler room is immediately south of and hydraulically upgradient of the electrical substation and railroad tracks which are part of the site (Area 18A). In January 2007, three groundwater monitoring wells were installed outside of the boiler room. The results were to be reported in the next MassDEP submittal, which was not available for review at the MassDEP file review. Soil borings were advanced within the basement area and indicated that the floor area was impacted with petroleum.

According to Somerville Fire Department, fuel oil was released outside of the building toward the railroad tracks. Based on the local topography, it appears that groundwater from the area of the release flows toward the proposed station site. Because the groundwater results were not available for review, it is possible that the release could impact the site.

#### Potential Presence of an Underground Storage Tank at the Homan's Building (Area 9A)

During the site reconnaissance of the Homan's Building (Area 9A), a suspected fuel oil tank fill pipe and vent pipe were observed on the outside of the rear wall of the building. The tank or the source of the suspected fill and vent pipe could not be in the interior of the building. According to documents reviewed at the Somerville Fire Department, a permit to install a 2,000-gallon tank in the basement was dated 1988. It is not known if that tank was aboveground or underground. In addition, during the site reconnaissance of the Homan's Building, a basement was not observed or inside the building. Therefore, it is possible that a UST, if present, may have impacted soil and groundwater at the property and is considered a REC.

#### Release at 350 Medford Street (Area 9A)

On July 23, 1998, a release of 60 gallons of diesel fuel occurred when the saddle tank on a delivery truck was damaged as the truck was backing into the parking lot of the Homan's Building. The RTN 3-17076 was assigned. As a result of the incident, diesel fuel flowed from the fuel tank to the paved surface of Medford Street, the paved parking lot of 350 Medford Street, a Bell Atlantic manhole on Medford Street and soils adjacent to the parking lot on a railroad right-of-way west of Medford Street. Impacted soil was removed from the railroad right-of-way and several rounds of confirmatory soil samples were collected. A Class A-2 RAO was submitted for this release on September 24, 1998 by Clean Harbors.

A release of OHM was identified at this site. The MassDEP database does not indicate that this RAO was audited, which may indicate that it was generally conducted in accordance with regulations in effect at the time. Changing site use or regulations, construction activities, a MassDEP audit of the RAO report, or identification of new environmental conditions could trigger the need to conduct additional assessment and/or remediation activities. Therefore, a release of OHM at this property is considered a REC.

## 5.16.5 Lowell Street Station, Somerville

Based upon the tasks conducted for the Phase I ESA, two RECs associated with the proposed Lowell Station site were identified.

### Underground Storage Tank at 20 Vernon Street (Area 10)

According to records reviewed at the Somerville Fire Department, the 20 Vernon Street building (Area 10) currently has one 10,000-gallon heating oil UST which was installed in 1946. It is not known if the tank has been tightness tested. Therefore, the integrity of the tank is unknown. As a result, it is possible that the UST may have impacted soil and groundwater at the property and is considered a REC.

### Historic and Current Use of 20 Vernon Street (Area 10)

According to historic Sanborn fire insurance maps, the location of 20 Vernon Street (Area 10) was used prior to and since 1900 as a furniture, paint-spraying machine, and box manufacturer, as well as a printer, shoe warehouse, and pipe shop. It was used by Rogers Foam Corporation sometime between 1950 and 1991 as a foam and rubber products manufacturer. This property has stored, used, generated and/or sold OHM. The OHM historically stored would typically include not only gasoline but also diesel fuel, waste oil, fuel oil, alcohol, paints, a variety of printing chemicals and degreasing chemicals which can contain chlorinated solvents. Therefore, historic uses of OHM at the property may have impacted soils or groundwater at the site. The potential exists for these contaminants to have been improperly disposed and to have impacted soil and groundwater at the property and is considered a REC.

### 5.16.6 Ball Square Station, Somerville and Medford

Based upon the tasks conducted for the Phase I ESA, four RECs associated with the proposed Ball Square Station site were identified.

#### Historic Use of 662-664 Boston Avenue Property (Area 13A) as Auto Repair Garage

According to historic Sanborn fire insurance maps, the property at 662-664 Boston Avenue (Area 13A) was historically used as an automobile repair garage since sometime prior to 1910. The Ball Square Auto Repair business currently operates at this property; therefore, this property has stored, used, and/or generated petroleum and other OHM. The OHM would typically include waste oil, fuel oil, alcohol, antifreeze, and degreasing chemicals which can contain chlorinated solvents. Historic and current activities may have resulted in a release of OHM and is considered a REC.

#### Release at 294 Harvard Street, Medford

The property at 294 Harvard Street is situated across the railroad tracks from the gas station at 590 Boston Avenue (Area 15) described below. The RTN 3-833 was assigned. According to files reviewed at the MassDEP, the 294 Harvard Street property was used as a fuel oil transfer station from the 1950s until 1985. Two USTs and 2,000 cubic yards of impacted soil were removed from this property in 1986. At the same time, three groundwater monitoring wells installed at that property contained light non-aqueous phase liquid (LNAPL) in each of the wells at an unknown thickness. In January 2008, a Phase I Report stated that LNAPL was "recently" encountered in a monitoring well at a thickness of 1.39 feet. Based on local topography, groundwater is assumed to flow in a westerly direction toward the railroad tracks and the 590 Boston Avenue property. Based on this information, conditions present at this property could impact soils or groundwater at the 590 Boston Avenue property and is considered a REC.

#### Release at Shell Service Station, 620 Broadway, Somerville

This property is adjacent to and southeast of the former veterinarian office building at 675 Broadway, Somerville property (Areas 13 and 13A). The RTN 3-1322 was assigned. It was first listed with MassDEP in 1990 due to the discovery of petroleum impacted soil which was encountered during a UST removal. In 2007, LNAPL was detected in several monitoring wells on this property; however, no LNAPL was detected in any of the wells bordering the railroad tracks opposite the 675 Broadway property. Several monitoring wells along the railroad tracks were sampled for gasoline and fuel oil parameters. The results showed that several of these parameters were detected above the applicable regulatory standards. Therefore, conditions present at this property may have impacted soil and groundwater at the 675 Broadway property and is considered a REC.

#### Release at Analetto Brothers, Inc., 590 Boston Avenue (Area 15)

This property consists of the gas station at 590 Boston Avenue (Area 15). The RTN 3-18017 was assigned. A release of OHM was identified at this site. A two-hour reporting condition for a release from drums of oil was reported to MassDEP on February 20, 1999. A Class A-1 RAO was filed with the MassDEP on April 20, 2001, indicating that a Permanent Solution was achieved and contamination was reduced to background. The MassDEP database does not indicate that this RAO was audited, which may indicate that it was generally conducted in accordance with regulations in effect at the time. Changing site use or regulations, construction activities, a MassDEP audit of the RAO report, or identification of new environmental conditions (such as indoor air impacts in nearby structures) could trigger the need to conduct additional assessment and/or remediation activities. Therefore, a release of OHM at this property is considered a REC.

### 5.16.7 College Avenue Station, Somerville and Medford

Based upon the tasks conducted for this Phase I ESA, two RECs associated with the proposed College Avenue Station site were identified.

#### Historic and Current Use of 175-179 College Avenue as a Printing Facility, Vehicle Repair Garage, and Presence of Underground Storage Tanks, and Documented Release

According to historic Sanborn fire insurance maps, a printing facility was on this property which is located adjacent to Area 16B between the early 1900s to the present. In addition, a vehicle repair garage and fuel USTs have also been on this property from sometime between 1910 and 1936 to the present. These facilities store, use, and generate petroleum and other OHM that would typically consist of motor oil, waste oil, fuel oil, alcohol, anti-freeze, degreasing chemicals that may contain chlorinated solvents, a variety of printing chemicals, and metals. The storage, use, and/or generation of these products may have or could result in a release of OHM and is considered a REC.

In addition, a gasoline release from an UST was reported to the MassDEP in 1998. A Class A-1 RAO was submitted to the MassDEP for this release, indicating that a Permanent Solution was achieved and that contamination was reduced to background. The MassDEP database does not indicate that this RAO was audited, which may indicate that it was generally conducted in accordance with regulations in effect at the time. Changing site use or regulations, construction activities, a MassDEP audit of the RAO report, or identification of new environmental conditions could trigger the need to conduct additional assessment and/or remediation activities. A release of OHM was identified at this site; therefore, this condition represents a REC.

#### Historic Use of Building Adjacent to 474 Boston Avenue as a Chemical Laboratory

According to historic Sanborn fire insurance maps, the building immediately southeast of Curtis Hall (474 Boston Avenue), adjacent to Area 16 was used as a chemical laboratory from sometime prior to 1897 until sometime between 1910 and 1936. It is likely that this laboratory stored and used OHM. The storage and/or use of these products may have resulted in a release of OHM, particularly given the age and OHM management practices utilized at that time, and is therefore considered a REC.

### 5.16.8 Union Square Station, Somerville

Based upon the tasks conducted for the Phase I ESA, four RECs associated with the proposed Union Square Station site were identified.

#### Historic Use of 51 Allen Street as Oil Supply Company, Junk Yard and Auto Repair Garage, Previous Existence of Underground Storage Tanks

According to historic Sanborn fire insurance maps, the property at 51 Allen Street was historically used as an oil supply company, a junk yard, and auto repair shop. The RTNs 3-24339 and 3-24921 were assigned. Photographs dated August 15, 2002 for this property reviewed at the Somerville Fire Department showed hundreds of automobile gas tanks, several large fuel storage tanks, and several 55-gallon drums being stored on the property. It is possible that releases from these OHM sources to soil and groundwater may have occurred. A letter from an attorney representing the owner of the property dated August 10, 1995 stated "you are using the premises for the storage of abandoned vehicles, tires, heavy metals, auto parts, and fluids which have penetrated the top surface of the owner's parking area. These conditions appear to disclose the existence of hazardous materials and petroleum products which you are allowing to remain on the premises…".

Fire Department records also showed that several USTs were removed from the property in 1967 and 1989. However, it was not indicated on the removal records if contamination was encountered during the removal of the tanks and detailed closure reports were not identified. Therefore, OHM may be present in the locations of the former USTs.

In 2004, several contaminants were detected in soil and groundwater at the property, including extractable petroleum hydrocarbons (EPH), PAHs, and PCBs in soil and EPH, PAHs, and volatile petroleum hydrocarbons (VPH) in groundwater. In November 2005, an MCP regulatory endpoint consisting of a Class A-2 RAO was submitted to the MassDEP, indicating that a Permanent Solution was achieved, but contamination was not reduced to background. A release of OHM was identified at this site. The MassDEP database does not indicate that this RAO was audited, which may indicate that it was generally conducted in accordance with regulations in effect at the time. Changing site use or regulations, construction activities, a MassDEP audit of the RAO report, or identification of new environmental conditions (such as indoor air impacts in nearby structures) could trigger the need to conduct additional assessment and/or remediation activities. The presence of multiple OHM sources and detection of OHM in site soil and groundwater is considered a REC.

#### Releases of PCBs and Other Contaminants at Nearby Properties

Releases of PCBs, petroleum products, and metals in soil and groundwater have occurred at neighboring properties north, west, and south of Areas 32, 33, 34, and 35. Since the contamination is pervasive in this area, there is a possibility that the contaminants from these properties have migrated to Areas 32, 33, 34 and 35, impacting soil and/or groundwater at these properties and is considered a REC.

#### Existence of USTs at 120 McGrath Highway/Route 28 (part of Area 30)

According to records reviewed at the Somerville Fire Department, a permit to install one 5,000-gallon diesel and one 5,000-gallon gasoline UST was granted for the property at 120 McGrath Highway/Route 28 (part of Area 30) on June 8, 1978. A UST Removal Permit was filed for two 5,000-gallon diesel and one 5,000-gallon gasoline USTs. However, it was not indicated on the removal records if contamination was encountered during the removal of the tanks and detailed closure reports were not identified. Therefore, OHM may be present in the locations of the former USTs, which constitutes a REC.

#### Existence of USTs at One Fitchburg Street (part of Area 30)

According to records reviewed at the Somerville Fire Department, a permit to install one 15,000-gallon No. 6 fuel oil UST, one 2,000-gallon gasoline UST and one 20,000-gallon fuel oil UST was granted to the One Fitchburg Street property (part of Area 30) on May 1, 1942. In 1987, a memo stated that none of the USTs at the property were in use. The 20,000-gallon UST was removed in 1987 and another UST had been filled in place. There was no mention of the third tank. It was not indicated in the removal records if contamination was encountered during the removal of the tanks and detailed closure reports were not identified. Therefore, OHM may be present in the locations of the former USTs. There are no records to indicate that all of the USTs that were reportedly installed at that property were, in fact, removed. Therefore, it is possible that a UST, the integrity of which is unknown, is still present at this location and OHM associated with USTs on this property may be present which would constitute a REC.

### 5.16.9 Summary

The Phase I Environmental Site Assessment indicates that the entire length of the project study corridor borders numerous sites of known and suspected OHM contamination, along with building materials that can include asbestos and lead.

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# 6 Environmental Consequences

## 6.1 Introduction

This chapter discusses the impacts that the Proposed Action may have on the resources described in Chapter 5, *Affected Environment*. Figure 1.1-2 shows the Proposed Action. Discussion of the No-Build Alternative is provided for comparison purposes.

The CEQ regulations at 40 CFR 1500 *et seq.* require an assessment of direct effects and their significance for Federally assisted projects. Direct effects are defined by the CEQ as effects "which are caused by the [proposed] action and occur at the same time and place…Effects includes ecological (such as the effects on natural resources and on the components, structures, and functioning of affected ecosystems), aesthetic, historic, cultural, economic, social, or health…Effects may also include those resulting from actions which may have both beneficial and detrimental effects, even if on balance the agency believes that the effect would be beneficial."

Indirect impacts are defined by CEQ as "effects which are caused by the [proposed] action and are later in time or farther removed in distance, but are still reasonably foreseeable. Indirect effects include growth-inducing effects and other effects related to changes in the pattern of land use, population density, or growth rate…" For this analysis indirect effects are defined as potential land use impacts of the project. In comparison, direct land use impacts are displacements of properties required for the project.

Cumulative impacts are de•ned by CEQ as "the impact on the environment which results from the incremental impact of the action when added to other past, present, and reasonably foreseeable future actions regardless of what agency (Federal or non-Federal) or person undertakes such other actions. Cumulative impacts can result from individually minor but collectively significant actions taking place over a period of time." Cumulative impacts include the direct and indirect impacts of a project together with the reasonably foreseeable future actions of others.

Indirect and cumulative impacts are discussed further in Section 6.15, *Indirect and Cumulative Effects*, of this EA.

## 6.2 Land Use

This section summarizes the direct effects on land use for the Proposed Action (see Section 5.2, *Land Use*, of this EA for information on the affected environment; and Section 6.15, *Indirect and Cumulative Effects*, of this EA for indirect effects not addressed in this section).

### 6.2.1 No-Build Alternative

There are no direct land use impacts under the No-Build Alternative.

### 6.2.2 Proposed Action

The land acquisitions for the Medford Branch are summarized in Table 6.2-1, and the land acquisitions for the Union Square Branch are summarized in Table 6.2-2. The Medford Branch (including the maintenance and storage facility) would affect 28 properties for a total of 13.7 acres, and the Union Square Branch would affect 12 properties for a total of 1.5 acres. Acquisitions are concentrated in the following areas: partial areas needed for track, Lechmere Viaduct, maintenance and storage facility, Gilman Square Station, Ball Square Station, and Union Square Station. Proposed property acquisitions at each proposed station site are shown on Figures 6.2-1 through 6.2-8.

Acquiring buildings and properties for the project at certain locations is unavoidable due to the dense urban character of the project study area. Despite the relative abundance of commercial and industrial properties in the affected cities, the acquisition and demolition of existing businesses could result in temporary reductions in local commerce as the affected businesses relocate or permanent reductions if the businesses do not reopen locally or at all. The use of the existing right-of-way minimizes the property acquisitions, which would be much higher for an extension that involved establishing a new right-of-way through these cities.

The use of the existing right-of-way for most of the tracks also avoids dividing and segmenting any neighborhoods, which could otherwise change the local neighborhood character. The proposed property acquisitions would not cut off access within any existing neighborhoods or block access from one neighborhood to another.

The Proposed Action is expected to decrease low intensity commercial and light industrial uses in the project study area and increase mixed-use, high-density TOD, particularly at the proposed Union Square and Ball Square Stations. Impacts to land, businesses, and residences have been minimized as much as possible through the use of existing transportation corridors.

Constructing the Proposed Action as currently designed would require approximately 15.2 acres of land acquisition from 40 properties, and would require relocating four active businesses. All property acquisitions and relocations will be conducted in compliance with the Uniform Relocation Act.[1] No residences would be displaced. The largest area acquisitions are for the project's maintenance and storage facility at the Option L site in Somerville (four parcels totaling 10.2 acres). In terms of impact, the most substantial acquisitions are those that require the displacement and relocation of four active businesses. These are located at Ball Square Station (two businesses—Ball Square Auto Repair and Ball Square Bowling Alley), Union Square Station (one business—Empire Marble & Granite), and the maintenance and storage facility (one business—M.S. Walker Wholesale Distribution). Tables 6.2-1 and 6.2-2 show the land acquisitions required for the extension on the Medford Branch (including the maintenance and storage facility) and the Union Square Branch, respectively.

For the proposed maintenance and storage facility at the Option L site, full parcel acquisitions are required at 20 Third Avenue (M.S. Walker Wholesale Distribution) and 44-48 Third Avenue (APCA Third Avenue, LLC), totaling 7.4 acres. The building located at 44-48 Third Avenue is being leased temporarily by a Federal agency as an indoor parking/storage facility for confiscated vehicles. Partial land acquisitions are required at 70 Inner Belt Road (CRG West Parking Lot) and 200 Inner Belt Road (Fine Arts Storage Partners), totaling 2.8 acres.

The NSTAR electrical substation on Medford Street near Gilman Square would need to be relocated. Discussions with NSTAR have indicated that the substation could be relocated on the same property, so the MBTA would acquire only a portion of this property.

The acquisitions in Union Square would likely decrease low intensity commercial and light industrial uses in the area of this station in favor of future mixed-use, high-intensity TOD. The acquisitions in Ball Square could change the character of development near the station, as the existing uses (a bowling alley and an auto repair shop) are not high intensity uses typically associated with TOD. The introduction of new high-capacity transit into a community would increase mobility and accessibility, which tends in turn to increase land values and development density. Additional indirect effects on land use are discussed in Section 6.15, *Indirect and Cumulative Effects*, of this EA.

1 United States Department of Transportation. 49 CFR Part 24, *Uniform Relocation Assistance and Real Property Acquisition Policies Act of 1970*, as amended. Public Law 91-646, January 2, 1971. Available at: http://www.fhwa.dot.gov/realestate/ua/uraguide3805.pdf

## Table 6.2-1 Land Acquisitions for the Medford Branch

| Address | Description | Reason for Acquisition | Area (sq. ft.) | Full or Partial Lot Acquisition |
|---|---|---|---|---|
| **Cambridge** | | | | |
| South of East Street | Archstone-Smith parcel | Viaduct | 6,963 | Partial |
| East Street | City-owned parcel | Viaduct | 1,549 | Partial |
| Water Street | City-owned parcel | Viaduct | 1,366 | Partial |
| Monsignor O'Brien Highway | NorthPoint parcel | Track junction | 240 | Partial |
| **Somerville** | | | | |
| 1 McGrath Highway | Lechmere Car Wash(undeveloped portion) | Tracks | 104 | Partial |
| 35 McGrath Highway | Commercial Warehouse (undeveloped portion) | Tracks | 295 | Partial |
| Monsignor O'Brien Highway | NorthPoint (undeveloped portion) | Viaduct | 35,703 | Partial |
| 20 Third Avenue | M.S. Walker Wholesale Distribution | Maintenance and Storage Facility | 200,972 | Full |
| 44-48 Third Avenue | APCA Third Avenue, LLC | Maintenance and Storage Facility | 121,540 | Full |
| 70 Inner Belt Road | CRG West Parking Lot | Maintenance and Storage Facility | 52,248 | Partial |
| 200 Inner Belt Road | Fine Arts Storage Partners | Maintenance and Storage Facility | 67,834 | Partial |
| Medford Street | NSTAR Electrical substation | Tracks | 37,947 | Full |
| 350 Medford Street | The Homan's Building (vacant, city-owned) | Gilman Square Station | 22,404 | Partial |
| 81 Highland Avenue | Somerville High School | Gilman Square Station | 1,545 | Partial |
| 20 Vernon Street | Roger's Foam Factory (parking lot) | Tracks | 2,779 | Partial |
| 61 Clyde Street | KSS Realty Partners (undeveloped portion) | Tracks | 4,348 | Partial |
| 42 Murdock Street #1, 2, 3 | 3-family residence/condo (yard) | Tracks | 260 | Partial |
| 46 Murdock Street | 2-family residence (yard) | Tracks | 260 | Partial |
| 50 Murdock Street | Vacant lot (yard) | Tracks | 260 | Partial |
| 54/56 Murdock Street | Rear of lot | Tracks | 260 | Partial |
| 675 Broadway (Somerville part)[1] | Lot 2: Veterinary office (vacant);<br>Lot 3: Karate studio | Ball Square Station | 11,540 | Full |
| 662 Boston Avenue (Somerville part) [1] | Auto Repair | Ball Square Station | 1,192 | Full |
| 664 Boston Avenue (Somerville part) [1] | Bowling Alley | Ball Square Station | 1,192 | Full |
| **Medford** | | | | |
| 675 Broadway (Medford part)[1] | Lot 2: Veterinary office (vacant) | Ball Square Station | 3,342 | Full |
| 662 Boston Avenue (Medford part)[1] | Auto repair | Ball Square Station | 5,032 | Full |
| 664 Boston Avenue (Medford part)[1] | Bowling alley | Ball Square Station | 5,032 | Full |
| 640/642 Boston Avenue | Arlex Taxi Corp/Powderhouse Condominiums (rear/parking lot) | Tracks | 1,739 | Partial |
| 590 Boston Avenue | Gas station/car wash (lot) | Tracks | 285 | Partial |
| 161College Avenue | Tufts University (undeveloped portion), | College Avenue Station pedestrian access | 2,617 | Partial |
| 179 College Avenue | Tufts University (undeveloped portion) | College Avenue Station access | 1,888 | Partial |
| Boston Avenue right-of-way | City-owned parcel | Tracks | 2,268 | Partial |
| **Total number of properties affected: 28** | | **Total Area: 595,004 square feet (13.7 acres)** | | |

1 These properties located in both Somerville and Medford are counted once for purposes of acquisitions.

### Table 6.2-2 Land Acquisitions for the Union Square Branch

| Address | Description | Reason for Acquisition | Area (square feet) | Full or Partial Lot Acquisition |
|---|---|---|---|---|
| **Somerville** | | | | |
| 51 McGrath Highway | Industrial Warehouse | Tracks | 2,364 | Partial |
| 35 Charlestown Street | Commercial (lot) | Tracks | 1,132 | Partial |
| 174 Somerville Avenue | Shopping mall (lot) | Tracks | 1,132 | Partial |
| 51 Allen Street | Auto repair (vacant) | Tracks | 31,761 | Full |
| 40 Bennett Street | Industrial Warehouse (lot) | Tracks | 1,004 | Partial |
| 50 Prospect Street | Empire Marble and Granite | Union Square Station | 24,282 | Full |
| 61 Medford Street | Commercial building(lot) | Tracks | 1,399 | Partial |
| 40 Horace Street | Single-family (lot) | Tracks | 75 | Partial |
| 41 Horace Street | Single-family (lot) | Tracks | 189 | Partial |
| 29 Harding Street | Commercial Warehouse | Tracks | 6 | Partial |
| 33 Earle Street (Lot 2) | Commercial Warehouse | Tracks | 45 | Partial |
| 33 Earle Street (Lot 24) | Commercial Warehouse | Tracks | 7 | Partial |
| **Total number of properties affected: 12** | | **Total Area: 63,396 square feet (1.5 acres)** | | |

## 6.2.3 Summary of Land Acquisitions

Constructing the Proposed Action as currently designed would require approximately 15.2 acres of land from 40 properties (28 for the Medford Branch and 12 for the Union Square Branch). The largest area acquisitions are for the project's transit vehicle maintenance and storage facility in Somerville (four parcels totaling 10.2 acres). In terms of impact, the most substantial acquisitions are those that require the displacement and relocation of four active businesses – Ball Square Station (two businesses—Ball Square Auto Repair, Ball Square Bowling Alley), Union Square Station (one business—Empire Marble & Granite), and the maintenance and storage facility (one business—M.S. Walker Wholesale Distribution). No residences would be displaced. All property acquisitions and relocations will be conducted in compliance with the Uniform Relocation Act.[2]

## 6.2.4 Consistency with Proposed Transportation Projects

The proposed Green Line Extension project is consistent with all applicable Federal, state, and local planning. It is fully consistent with the SIP[3] and highly supportive of

2 United States Department of Transportation. 49 CFR Part 24, *Uniform Relocation Assistance and Real Property Acquisition Policies Act of 1970*, as amended. Public Law 91-646, January 2, 1971. Available at: http://www.fhwa.dot.gov/realestate/ua/uraguide3805.pdf

3 Massachusetts Department of Environmental Protection. Comment Letter on the *Green Line Extension Draft Environmental Impact Report/Environmental Assessment*. January 8, 2010. [A copy of this letter is provided in Appendix A of this document].

local, regional, state, and Federal policies related to transportation facilities including transit, pedestrian, and bicycle facilities and services. The communities in the project study area are pursuing a number of transportation and development projects that are of importance to the project study area. Descriptions of the key features of these undertakings are provided in the following section, which also discuss their relationship to the Proposed Action.

## Somerville Community Path

The Somerville Community Path currently travels through the Davis Square area of Somerville to Cedar Street, and connects with other elements of the regional multi-use path system in Cambridge, Belmont, and Arlington. A proposed extension of the Somerville Community Path would create a new connection of the Path from its future endpoint at Lowell Street in Somerville to the Inner Belt area (also in Somerville), with potential connections beyond to east Cambridge and Boston. In general terms, the proposed route follows the edge of the MBTA Lowell Line, generally located at street level, while the existing heavy rail and proposed Green Line trains would run below, in a cut section.

As part of its commitment to the Somerville community, MassDOT has agreed to complete all planning, design, and engineering work – including the identification of necessary property acquisitions – for the proposed extension of the Somerville Community Path between Lowell Street and Inner Belt Road. Nevertheless, the City of Somerville remains the chief proponent for the extension of the Community Path. Wherever possible, MassDOT would design the extension of the Community Path in such a way that direct connections can be made from the Path extension to the Green Line Extension stations. MassDOT has not, however, committed to fund or build the Somerville Community Path as part of the Green Line Extension project, nor has the Path been identified as project-related mitigation in any of MassDOT's environmental review documents (*i.e.*, NEPA and MEPA documents).

The Green Line Extension project and the construction of the extension of the Somerville Community Path are separate and distinct projects, with their own project-development trajectories and timelines. Furthermore, it is most likely that the two efforts would have separate funding sources.

In order to avoid precluding the potential eventual construction of the Community Path extension, MassDOT has made the following construction commitments as they pertain to the extension of the Somerville Community Path:

- To design and construct the Green Line Extension project in such a way that it does not preclude the eventual construction of the extension of the Somerville Community Path.

- To design and construct those elements of project infrastructure – including certain retaining walls and bridge spans – which are needed by both the Green Line Extension project and the extension of the Somerville Community Path.

In addition, MassDOT would assist the City of Somerville and any other stakeholders to locate funding opportunities for the construction of the Community Path.

As part of its development of the EA for the Green Line Extension project, MassDOT would ***not*** be including the extension of the Somerville Community Path for review under NEPA. This is the case for several important reasons, and doing so does not inappropriately segment the two efforts under NEPA (§ 771.111(f)). This is the case because:

- The Green Line Extension and the extension of the Somerville Community Path each have their own termini – different for the two projects – and both are of sufficient length to be able to sufficiently and accurately analyze any independent environmental impacts.
- The two projects have utility independent of each other and could exist without the other as worthwhile and beneficial investments. This could be the case for the Green Line Extension project, should the extension of the Community Path never be built. That being said, there is synergy between the two projects, given that use of the Community Path Extension would certainly provide Green Line Extension riders with an additional way to access the stations, and could thereby increase non-automobile access to the stations. The projected success of the Green Line Extension stations, and their predicted ridership, however, is not predicated on the completion of the Community Path Extension.
- The Green Line Extension project is being built so as not to preclude any future construction of an extension of the Somerville Community Path, and would in fact be built so as to allow for multiple alternative designs of the eventual path extension.

As prepared by MassDOT, the design of the extension of the Somerville Community Path would comply with all applicable accessibility regulations, including those found in the ADA and Regulations of the Massachusetts AAB. In addition to these regulations, other documents relevant to path design would be used, including:

- *Draft Final Accessibility Guidelines for Outdoor Developed Areas*, Architectural and Transportation Barriers Compliance Board (October 10, 2009);
- Designing Sidewalks and Trails for Access Part II of II: Best Practices Design Guide, Federal Highway Administration (September 2001);
- *Guide for the Development of Bicycle Facilities*, American Association of State Highway and Transportation Officials (1999); and
- *Project Development & Design Guide*, Chapter 11, Shared Use Paths and Greenways, MassDOT Highway Division (2006).

As appropriate, the design of the extension of the Somerville Community Path would be presented and reviewed in public meetings and workshops, as well as directly with stakeholders including the City of Somerville, the City of Somerville Commission for Persons with Disabilities, and advocates for the Community Path extension.

## Grand Junction Rail-with-Trail

The *Grand Junction Rail-with-Trail Feasibility Study* (October 2006) examined the potential alignments for creating a non-motorized trail along an historic rail corridor in Cambridge while maintaining current rail operations. The previously mentioned *2001 Eastern Cambridge Planning Study* recommended creation of a path along the Grand Junction corridor to enhance non-vehicular mobility. The trail would create a major north-south bicycle and pedestrian connection between Boston, MIT, several Cambridge neighborhoods (including east Cambridge), and Somerville. The trail is proposed to end at the Cambridge/Somerville City Line after crossing Gore Place. It would connect to parklands in NorthPoint via the street network. There is also potential for it to connect to the extended Community Path in Somerville.

## NorthPoint Development

NorthPoint is the 45-acre area in Cambridge adjacent to the relocated Lechmere Station site. NorthPoint has been part of a planning initiative undertaken by the City of Cambridge to promote a new, dense urban neighborhood. The area is within the Charles River Basin area between the Charles River Esplanade and Boston's Harbor Park. The proposed mixed-use development includes up to 21 buildings with 2,700 residential units, 2.1 million square feet of office/lab space, and 75,000 square feet of retail space. This project has been reviewed under MEPA. The Certificate was issued in December 2002 (EEA # 12650).

The NorthPoint development would transform a formerly underutilized area of land straddling Boston, Cambridge, and Somerville into a mixed-used, transit-oriented neighborhood. The groundbreaking for the NorthPoint development occurred in March 2005. Phase I construction included two residential buildings totaling 329 condominiums, and half of the 10-acre Central Park green space. The NorthPoint project would require continuing coordination among the private developer, the communities, and the MBTA, particularly as the Lechmere Station relocation is undertaken.

The proposed Archstone-Smith development, adjacent to NorthPoint, is a planned residential community. The project redevelops a former warehouse and retail operation into an apartment complex consisting of approximately 750 housing units in two buildings. A parking structure for approximately 900 spaces is also proposed. Phase I, which includes 437 rental units, was completed in 2007. Phase II is permitted for 426 units.

Together, the NorthPoint and Archstone-Smith developments would be important contributors to riders to the Green Line Extension project. These projects would add hundreds of residences, plus businesses and workers, within a short walk of the relocated Lechmere Station. The projects would also replace the 165 existing Lechmere Station parking places that would not be immediately replaced at the relocated Lechmere Station. In order to properly design station platforms, service headways, and the required number of Green Line vehicles, it is crucial to account for their transit ridership contribution to the expanded Green Line ridership. It is also important to note that NorthPoint and the Archstone-Smith residential projects are TODs that can contribute to Green Line Extension project's objectives to promote a decrease in automobile dependence within the project study area.

## Reconstruction of McGrath Highway /Route 28

In 2008, the CTPS prepared a report entitled *Toward a Route 28 Corridor Transportation Plan: An Emerging Vision*. This report summarized information on traffic studies and potential land use changes in the McGrath Highway/Route 28 corridor, and how redevelopment would impact traffic patterns. The McGrath Highway/Route 28 is roughly parallel to the proposed Green Line Extension between the relocated Lechmere Station and Washington Street Station and is elevated through the northern portion of this segment.

The City of Somerville has expressed a desire to modify McGrath Highway from its current "other freeway" classification to a street more similar to a boulevard. The City believes this would facilitate movement across the project study area by current Somerville residents and visitors, and create a more attractive environment for redevelopment along the project study area. MassDOT has recently selected a consultant to complete a study of the McGrath Highway through this area. The study is expected to take 18 months after the award of the contract.

The purpose of the study is to:

- Evaluate the current usage of the McGrath Highway beyond the analysis from the CTPS and look at traffic from a post-Central Artery/Tunnel project perspective.
- Evaluate current usage of other major roads in the project study area, including I-93, Mystic Avenue, Broadway, Highland Avenue, Medford Street, Washington Street, and Somerville Avenue in Somerville; Rutherford Avenue and Austin Street in Boston; and Monsignor O'Brien Highway and Land Boulevard in Cambridge, including identifying any potential changes for these roadways.
- Determine the impacts to McGrath Highway congestion and to other project study area roadways from various lane configurations on an at-grade or below-grade McGrath Highway.

- Make recommendations for the project limits of an elevated structure removal project (based on the conditions of the existing structures, the need to segregate rail traffic, the resulting opportunities for new connections and redevelopment opportunities, and the impacts on safety).
- Identify opportunities for new development parcels and/or park space from an overall reduction in right-of-way width potentially made possible by the elimination of elevated structures.

## Urban Ring Project

The Urban Ring project, in the planning stages and currently on-hold due to funding constraints, is a three-phased, circumferential transit improvement project within a corridor approximately two miles outside the downtown Boston core. The project includes segments within the municipalities of Boston, Cambridge, Somerville, Brookline, Everett, Medford, and Chelsea, which are some of the fastest growing areas around Boston. The Urban Ring would provide new transit services that would connect to existing radial transit lines (subway, commuter rail, and bus) to create shorter transit trips and fewer transfers in the project study area. When constructed, the Urban Ring would connect with the Green Line Extension at Lechmere Station. The Green Line Extension project would not preclude construction of the planned Urban Ring project.

## Assembly Square Orange Line Station

The Assembly Square redevelopment district in Somerville is a proposed large-scale, mixed use redevelopment project of 2,100 residential units, more than 2.75 million square feet of retail and office space, and a 200-room hotel. A new MBTA Orange Line station between the Wellington and Sullivan Square stations is planned to provide regional transit access and an alternative to auto traffic. Design of this project is underway and the MBTA is seeking FTA funding in addition to funding committed by the Federal Realty Investment developer team to complete design and construct the station.[4]

The proposed MBTA Orange Line Assembly Square Station would provide direct transit access to downtown Boston and points north. The Assembly Square project proponent, FR Sturtevant Street LLC, has committed $15 million to fund design and construction of the new station. The station project is designed to encourage pedestrian access to the station and a shared use path paralleling the MBTA right-of-way is planned. A second headhouse was added to the 30 percent design plans for the station to provide better pedestrian access. This enhancement was made

4 Massachusetts Bay Transportation Authority. “About the MBTA/T Projects”. Available at: http://www.mbta.com/about_the_mbta/t_projects/. Viewed September 17, 2010.

possible through $10 million in additional state highway flex funding. The station has been advertised for construction. A construction contract is expected to be submitted to the MBTA Board of Directors in the fall of 2011.

The proposed MBTA Assembly Square Station is an important element in the planning of the Green Line Extension. To properly project Green Line ridership, it is crucial to understand the relationship between the service the new Orange Line station would provide to the surrounding neighborhoods and how that service would affect the future ridership draw onto the proposed Green Line Extension.

## 6.3 Socioeconomic Impacts

This section addresses the economic effects of property acquisition for the project and the possible social effects on local communities. Direct and indirect effects of land acquisitions are discussed in greater detail in Section 6.2, *Land Use*, and Section 6.15, *Indirect and Cumulative Effects*. Specific analyses of environmental justice populations, including land acquisition and changes in transit access, can be found in Section 6.4, *Environmental Justice*. Details on construction impacts are provided under each specific resource in this chapter and also in Chapter 4, *Alternatives*, of this EA.

### 6.3.1 No-Build Alternative

No properties would be acquired under the No-Build Alternative, and there would be no change in transit service, resulting in no disruption of existing businesses and no direct socioeconomic impacts or benefits.

### 6.3.2 Proposed Action

Forty properties would be affected under the Proposed Action, consisting of 28 for the Medford Branch (including the maintenance and storage facility) and 12 for the Union Square Branch. Table 6.3-1 lists the annual property taxes for the properties to be acquired.

The total estimated property tax value of the land and buildings acquired for the Proposed Action is $445,232. These acquisitions would reduce property tax revenue by $7,099 in Cambridge, $17,945 in Medford, and $420,188 in Somerville. The property tax impact is largest in Somerville because most of the proposed acquisitions would be in Somerville. A total of 204 jobs would be displaced or relocated, the majority of which (194 jobs) are in Somerville.

## Table 6.3-1 Property Tax Effects of the Proposed Action

| Property | Type | Annual Property Taxes on Acquired Area[1] | Estimated Jobs Displaced or Relocated[2] | Purpose of Acquisition |
|---|---|---|---|---|
| **Cambridge** | | | | |
| Non-building acquisitions | Vacant lots, strip acquisition, etc. | $ 7,099 | 0 | Varies |
| **Somerville** | | | | |
| 20 Third Avenue | Commercial/Industrial building | $120,420 | 183 | Maintenance and Storage Facility |
| 44-48 Third Avenue | Commercial/Industrial building (vacant) | $138,005 | 0 | Maintenance and Storage Facility |
| Medford Street | Substation | $16,567 | 0 | Tracks |
| 675 Broadway | Commercial building (vacant) | $8,436 | 0 | Ball Square Station |
| 662/664 Boston Avenue | Commercial/industrial building | $703 | 0 [3] | Ball Square Station |
| 51 Allen Street | Commercial/industrial building (vacant) | $4,025 | 0 | Union Square Station |
| 50 Prospect Street | Commercial/industrial building | $22,971 | 11 | Union Square Station |
| Non-building acquisitions | Vacant lots, strip acquisition, etc. | $109,061 | 0 | Varies |
| **Medford** | | | | |
| 675 Broadway | Commercial building (vacant) | $4,937 | 0 | Ball Square Station |
| 662/664 Boston Avenue | Commercial/industrial building | $10,979 | 10 | Ball Square Station |
| Non-building acquisitions | Vacant lots, strip acquisition, etc. | $2,029 | 0 | Varies |
| **Subtotals:** | **Cambridge** | **$7,099** | **0** | |
| | **Somerville** | **$420,188** | **194** | |
| | **Medford** | **$17,945** | **10** | |
| **TOTAL** | | **$445,232** | **204** | |

1 Annual property taxes estimated based on local property tax rates and the most recent assessed value (as of 2010) of any buildings and land involved. Annual property taxes for partial acquisitions are prorated based on the square footage taken from each parcel.

2 Jobs estimated based on data from InfoUSA and publicly available data. Municipal buildings are assumed to relocate within the same city and cause no net change. Vacant buildings are assumed to have no jobs under existing conditions.

3 The number of estimated jobs displaced or relocated for this property are listed under Medford, as the majority of the property is within this municipality.

### Community Disruption

The Proposed Action is expected to correct existing and future conditions that cause community disruption (limited mobility, traffic congestion, noise and vibration associated with railroads, and poor air quality). The Proposed Action would provide roadway and traffic signal modifications at 12 intersections and pedestrian improvements at 29 intersections. For locations along the existing commuter rail lines, the future noise levels are expected to be substantially lower than the existing noise levels due to noise barriers installed for the project. The project would reduce daily VMT by 25,728, improving air quality and providing zero-emission transportation capacity for anticipated growth. The Proposed Action is not expected to disrupt community parks or recreation sites, as discussed in Section 6.11, *Parks and Recreation Areas*.

The Proposed Action is expected to cause temporary disruptions during construction which include temporary bridge closures and traffic detours, potential loss of on-street parking and potential noise and vibration impacts. The Proposed Action would reconstruct seven roadway bridges over the proposed alignment, three railroad bridges above streets on the Medford Branch, and one mainline light rail bridge over the MBTA Fitchburg Line. Additionally, three light rail viaducts would be constructed. The design and construction of these bridges would be coordinated with appropriate municipal personnel in Cambridge, Somerville, and Medford. Additional details on construction staging and sequencing are provided in Section 4.4.10, *Construction Staging and Sequencing*. MassDOT has committed to mitigate these impacts; construction period mitigation commitments are described in Section 7.5, *Construction Period Mitigation,* of this EA.

The use of the existing MBTA commuter rail rights-of-way for the proposed tracks (located primarily below grade, in a dedicated cut section) greatly reduces temporary construction impacts. Bridge reconstruction would be staged whenever possible to maintain traffic over the respective bridges during construction. Construction staging would be required for roadway traffic as well as rail traffic beneath the bridges. In some cases staged construction is not feasible and the bridge would have to be closed during construction. A detour would be required to provide alternative traffic routes during construction. Close coordination with the MBTA, City of Somerville, City of Medford, and the respective Fire and Police Departments will address specific construction issues. A comprehensive construction staging and sequencing plan would be developed and included in the final construction contract documents and communicated to the public. The preliminary analysis of construction staging and sequencing shows that it is feasible to construct the project while maintaining railroad operating, access to abutters, and traffic and pedestrian paths. The construction staging plans will outline a rolling work zone, to limit construction impacts to one segment of the corridor at a time. Project bridge designs and construction staging plans would be refined during preliminary engineering in coordination with the communities.

Construction contractors would be required to comply with relevant Federal, state, and local laws, regulations, and codes to eliminate or minimize adverse effects (such as increases in noise and vibration levels, and disruptions in traffic flow) to environmental and social resources. On-site engineers and inspectors would monitor all construction activities to ensure that mitigation measures are properly implemented.

Some members of the public have expressed concern about potential noise and vibration impacts of the Proposed Action once it begins operating. Potential noise and vibration impacts from the project are described in Section 6.7, *Noise*, and Section 6.8, *Vibration*, respectively. MassDOT has complied with FTA-established guidelines to identify and then eliminate, minimize, or mitigate noise and vibration impacts above regulatory thresholds to sensitive receptors. Where appropriate, MassDOT intends to implement these measures prior to construction. Chapter 7, *Project and Mitigation Commitments*, of this EA describes the process by which mitigation measures would be identified and implemented for these noise and vibration impacts.

MassDOT and the MBTA are committed to continuing a robust public involvement process during the construction of the Green Line Extension (see Section 2.6.4, *Continued Public Involvement through Design and Construction*, of this EA for additional details). More discussion on the community involvement strategies during design and construction is found in the PIP.[5] Strategies would a) inform the public of construction plans, b) provide regular updates on construction, traffic detours and other impacts, and c) solve problems that arise during construction. Key elements of the construction outreach plan include:

- Establishing a project construction office;
- Establishing the position of Green Line Extension project Ombudsman who would field all construction-period comments and complaints, coordinate with the cities, and respond to public concerns;
- Establishing a Construction Working Group to advise MassDOT and the MBTA;
- Establishing a project email address and 24-hour phone hotline for public concerns;
- Providing frequent website updates of construction activities at www.mass.gov/greenlineextension;
- Hosting neighborhood construction kick-off meetings;
- Producing quarterly construction updates; and
- Developing a business outreach plan to assist local businesses during construction.

## Economic Effects

Table 6.3-1 summarizes the property tax value of the buildings and vacant land to be acquired for the Proposed Action. Table 6.3-2 summarizes the tax value decreases by city. Cambridge would have a negligible tax loss of $7,099 (0.002 percent of Cambridge property tax revenue in fiscal 2010) under the Proposed Action. Medford would have a tax loss of $17,945 (0.02 percent of Medford property tax revenue in fiscal 2010). Somerville would have the greatest tax revenue decrease: $420,188 (0.4 percent of Somerville tax revenue in fiscal 2010).

5 Massachusetts Department of Transportation. *Final Environmental Impact Report (Volumes 1, 2 and 3), Chapter 6 – Public Involvement Plan*, June 2010. Prepared by Regina Villa Associates and Vanasse Hangen Brustlin, Inc. Available at: http://www.greenlineextension.org/docs_finalEIR.html

**Table 6.3-2 Property Tax Decreases by City**

| Cambridge | | Somerville | | Medford | |
|---|---|---|---|---|---|
| Tax revenue decrease | % of City total | Tax revenue decrease | % of City total | Tax revenue decrease | % of City total |
| $7,099 | 0.002% | $420,188 | 0.4% | $17,945 | 0.02% |

The Proposed Action would result in some job displacement or relocation. Table 6.3-3 summarizes the job displacements or relocations for each city. The Proposed Action would displace an estimated 204 jobs, the majority (194 jobs) in Somerville. Medford would have 10 jobs displaced, while no jobs would be displaced in Cambridge. By comparison, the 2000 U.S. Census estimated the workforces of Cambridge, Somerville, and Medford at 59,965 workers, 47,656 workers, and 30,133 workers, respectively.

**Table 6.3-3 Estimated Job Decreases or Relocations**

| | Cambridge | Somerville | Medford | TOTAL |
|---|---|---|---|---|
| Proposed Action | 0 | 194 | 10 | 204 |
| Work Force in City | 59,965 | 47,656 | 30,133 | 137,754 |

Source: United States Census Bureau, *Census 2000*. Available at: http://www.census.gov
(Total work force included to demonstrate scale of impacts.)

Many of the jobs displaced would likely be relocated or replaced within the affected cities because there is an inherent economic advantage to being located close to public transit and to educational and social centers such as Tufts University and Union Square.

## 6.3.3 Summary

The Proposed Action would provide increased transit access, which increases both the potential for local commerce and the potential for area residents to commute to jobs elsewhere, as described in Section 6.15, *Indirect and Cumulative Effects*. However, the Green Line Extension would require acquiring and demolishing eight buildings to accommodate the proposed stations. Somerville would have the greatest tax revenue decrease of $420,188 (0.4 percent of Somerville tax revenue in fiscal 2010). Medford would have a tax loss of $17,945 (0.02 percent of Medford property tax revenue in fiscal 2010). Cambridge would have a negligible tax loss of $7,099 (0.002 percent of Cambridge property tax revenue in fiscal 2010). The Proposed Action would displace an estimated 204 jobs, the majority (194 jobs) in Somerville.

## 6.4 Environmental Justice

This section discusses the possible beneficial and adverse impacts to environmental justice populations for the Proposed Action in comparison to the No-Build Alternative. Possible benefits to disability populations are also discussed. The project must comply with DOT requirements for environmental justice as developed through Executive Order 12898 and DOT Order 5610.2, as outlined in Section 5.4, *Environmental Justice Populations,* of this EA.

The Boston Region MPO's CTPS conducted transit access modeling for disability and environmental justice populations to assess the benefits of the Proposed Action in comparison to the No-Build Alternative. The CTPS reports are provided in Appendix C, *Environmental Justice Analysis and Disability Impact Analysis*. These analyses examined the number of destinations within a 40-minute transit trip and included the following types of destinations:

- The number of basic, retail, and service jobs, to assess access to employment opportunities;
- The average number of students at two- and four-year institutions of higher education, to assess educational opportunities; and
- The average number of hospital beds, to assess the availability of medical care.

Environmental justice populations could be disproportionately affected if adverse impacts are concentrated in environmental justice communities. As required by DOT Order 5610.2, a broad range of potential adverse effects to environmental justice populations were evaluated. Of these, land acquisition (and potentially related job displacement) and increases in noise levels were determined to have a potential to adversely impact environmental justice populations. The following sections summarize transit access improvements as well as adverse effects of land acquisition and noise impacts for the No-Build Alternative and Proposed Action. Land acquisitions are discussed in detail in Section 6.2, *Land Use*. Noise impacts are discussed in detail in Section 6.7, *Noise*.

### 6.4.1 No-Build Alternative

There would be no disproportionate impacts to environmental justice populations. No land would be acquired under the No-Build Alternative. No changes in noise are anticipated under the No-Build Alternative. This alternative would not benefit environmental justice populations by improving access to transit services or reducing noise from trains.

### 6.4.2 Proposed Action

Environmental justice and disability populations would realize an improvement in access to jobs, colleges, and health care from the Proposed Action. Non-environmental justice and non-disability populations would also realize a benefit. Table 6.4-1 summarizes the percent change in access to transit, as compared to the No-Build Alternative, that would result from the Proposed Action.

**Table 6.4-1 Changes in Transit Access for Disability and Environmental Justice Populations**

| Population | Basic Employment [1] | Retail Employment [2] | Service Employment [3] | College Enrollment [4] | Hospital Beds [5] |
|---|---|---|---|---|---|
| Disability | +7.0% | +6.8% | +6.0% | +15.5% | +2.5% |
| Non-Disability | +2.9% | +4.0% | +2.7% | +5.0% | +1.3% |
| Environmental Justice | +4.3% | +4.8% | +3.7% | +9.3% | +1.5% |
| Non-Environmental Justice | +4.8% | +5.6% | +4.6% | +8.0% | +2.3% |

Source: United States Census Bureau, *Census 2000*. Central Transportation Planning Staff (CTPS) analysis.
Analysis is based on number of jobs, average number of enrolled students, and average number of hospital beds within a 40-minute transit trip of the populations listed.

1 Percent improvement in number of “blue-collar” jobs accessible to residents in each census block via transit, within a 40-minute ride distance.
2 Percent improvement in number of retail sales jobs accessible to residents in each census block via transit, within a 40-minute ride distance.
3 Percent improvement in number of “white-collar” jobs accessible to residents in each census block via transit, within a 40-minute ride distance.
4 Percent improvement in number of colleges accessible to residents in each census block via transit, within a 40-minute ride distance.
5 Percent improvement in number of hospitals accessible to residents in each census block via transit, within a 40-minute ride distance.

The rail service expansion offered by the Proposed Action would increase transit access for all affected populations in all categories assessed by 1.3 percent to 15.5 percent. Disability and environmental justice populations would have better access to transit services to jobs, colleges, and hospitals than is available under the No-Action Alternative. Disability populations would benefit more than non-disability populations in all categories, and environmental justice and non-environmental justice populations would generally have similar increases.

Four businesses would be acquired for the Proposed Action. These are located at Ball Square (two businesses—Ball Square Auto Repair, Ball Square Bowling Alley), Union Square (one business—Empire Marble & Granite), and the Option L maintenance and storage facility site (one business—M.S. Walker Wholesale Distribution). All other acquisitions would involve strips of land or vacant lots and would not require building demolition. Table 6.4-2 lists the buildings involved and identifies the environmental justice and racial breakdown of the affected census block groups.

**Table 6.4-2 Active Business Acquisitions, Job Displacements and Local Demographics**

| | | | | Percentage of Local Population by Race | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Address | Business Type | Jobs Displaced | State EJ Status | White | Black | Native American | Asian | Pacific Islander | Other | Multi. | Hisp.[1] |
| 662 Boston Avenue, Medford & Somerville | Commercial/ industrial | 5 | FM | 82.2% | 3.2% | 0.0% | 9.2% | 0.0% | 0.6% | 4.8% | 4.1% |
| 664 Boston Avenue, Medford & Somerville | Commercial/ industrial | 5 | FM | 82.2% | 3.2% | 0.0% | 9.2% | 0.0% | 0.6% | 4.8% | 4.1% |
| 50 Prospect Street, Somerville | Commercial/ industrial | 11 | FM | 60.0% | 10.3% | 0.0% | 6.8% | 0.0% | 16.8% | 6.1% | 11.1% |
| 20 Third Avenue, Somerville | Commercial/ industrial | 183 | FM | 95.6% | 0.0% | 0.0% | 0.0% | 1.5% | 0.0% | 0.0% | 2.9% |
| Medford | | | | 86.5% | 5.9% | 0.2% | 4.2% | 0.0% | 1.1% | 2.1% | 2.5% |
| Somerville | | | | 77.0% | 6.4% | 0.4% | 6.5% | 0.1% | 4.9% | 4.8% | 8.6% |

F = Foreign-born M = Minority I = Income (poverty)

Source: United States Census Bureau, *Census 2000*, Massachusetts Geographic Information System (MassGIS)

1 Hispanic populations are already included within the other racial categories but are listed separately as well for clarity. The percentages for each city would add up to more than 100 percent.

None of the buildings are residences and therefore would not affect environmental justice populations directly. The four buildings are located within environmental justice areas, in areas with similar racial populations to the rest of the region. The acquisition in Union Square (50 Prospect Street) is surrounded by different racial demographics than the rest of Somerville, but they match the demographics of the Union Square area as a whole. Most of Union Square is an environmental justice area, which makes any construction there likely to affect environmental justice populations.

All jobs that would be displaced or relocated (204) are located in environmental justice areas. While the analysis cannot assume that the employees of these businesses are local residents, the local racial makeup and economic status provides the best available indicator for the affected populations. As discussed in Section 6.3, *Socioeconomic Impacts*, the displacement of these jobs would not represent a substantial economic change for the local area. All acquisitions and relocations will be conducted in compliance with the Uniform Relocation Act[6] and the MBTA's real estate acquisition process. Relocation assistance programs for displaced businesses and their employees are available through the U.S. Department of Housing and Urban Development and the Massachusetts Department of Housing and Community Development's Bureau of Relocation.

Under the Proposed Action with no mitigation, 152 sensitive receptors would have moderate to severe noise impacts, including 82 buildings in environmental justice areas. Approximately 54 percent of the noise impacts to sensitive receptors would be

6 United States Department of Transportation. 49 CFR Part 24, *Uniform Relocation Assistance and Real Property Acquisition Policies Act of 1970*, as amended. Public Law 91-646, January 2, 1971. Available at: http://www.fhwa.dot.gov/realestate/ua/uraguide3805.pdf

in environmental justice areas. As noted in Section 5.4, *Environmental Justice Populations*, of this EA, approximately 52.7 percent of Cambridge residents, 68.5 percent of Somerville residents, and 22.2 percent of Medford residents live in environmental justice areas, which indicates that the impacts on environmental justice populations would be roughly proportionate. With mitigation measures such as noise barriers and sound insulation in place, there would be no residual impacts to these areas and therefore no disproportionate impacts. Noise impacts, specific buildings impacted, and proposed mitigation measures are discussed in greater detail in Section 6.7, *Noise.*

### 6.4.3 Public Outreach

Public outreach is a key requirement of DOT Order 5610.2. Public outreach efforts for the Green Line Extension project have included targeted efforts to reach environmental justice populations. Meetings on the Green Line Extension project have attempted to reach as many residents as possible by ensuring that meetings and project materials were widely available and in a variety of formats.

- The majority of the project Advisory Group meetings were covered by local cable television stations to ensure that individuals could view the proceedings even if they were not able to attend the meetings in person. Meeting presentations and minutes were transcribed onto audio tape on behalf of visually impaired persons.
- The series of station workshops was held in local environmental justice neighborhoods, and flyers advertising these workshops and other meetings were distributed at MBTA Orange Line stations and local bus stops in Spanish, English, and Portuguese. These flyers were also distributed door-to-door to potential abutters to the stations (both residential and business in these environmental justice neighborhoods) in advance of the meeting.
- At the public meetings and station workshops, interpreters were also available upon request for participants. All English-language meeting announcements included a statement in Spanish, Portuguese, and Haitian Creole offering to translate the announcement.
- The project fact sheet was translated into Spanish. A large-print fact sheet was developed for visually impaired persons. These materials were distributed at public meetings, on the project website and upon request. Audio equipment was employed at all meetings to accommodate hearing impaired participants in the community.
- The project database includes multiple community, neighborhood, and environmental justice organizations in the three affected communities. Announcements for the final set of public meetings were mailed to all residents of the neighborhood of east Cambridge, as well as the municipalities of Somerville and Medford, to assure the widest possible outreach to environmental justice residents.

Environmental justice issues were frequent topics in meetings with the communities, with planning organizations, and with local officials. The project team also met with many neighborhood and community organizations to provide project briefings to community members and listen to their concerns. These organizations included the Disability Commissions in Cambridge, Somerville, and Medford.

### 6.4.4 Summary

Four active businesses with 204 jobs would be impacted in environmental justice areas, as shown in Table 6.4-3. All relocations will be conducted in compliance with the Uniform Relocation Act[7] and MBTA's real estate acquisition process. The Proposed Action would increase transit access to jobs, colleges, and health care by 1.5 percent to 9.3 percent for environmental justice populations and from 2.5 percent to 15.5 percent for disability populations. With mitigation in place, the project would have no residual impacts from noise and would have no disproportionate impacts on environmental justice populations. Noise impacts and mitigation are discussed in detail in Section 6.7, *Noise*.

**Table 6.4-3 Summary of Project Impacts in Environmental Justice Areas**

| Active Businesses Acquired | Jobs Displaced | Sensitive Receptors Affected by Noise | |
|---|---|---|---|
| | | Without Mitigation | With Mitigation |
| 4 | 204 | 152 | 0 |

## 6.5 Traffic and Transportation Systems

This section discusses the direct, indirect, and cumulative effects of the Proposed Action with respect to intersection, pedestrian, bicycle, public bus transportation, and parking systems in the project study area. This evaluation is based on an assumed build year of 2015 and a 2030 horizon year.

Project impacts are determined by comparing intersection LOS, pedestrian and bicycle circulation, and parking for the No-Build Alternative and Proposed Action. The evaluation addresses traffic circulation on roadways adjacent to proposed station locations. Mitigation measures at locations where the Proposed Action would impact traffic operations are described in Section 7.3.3, *Traffic and Transportation Systems*, of this EA.

7 United States Department of Transportation. 49 CFR Part 24, *Uniform Relocation Assistance and Real Property Acquisition Policies Act of 1970*, as amended. Public Law 91-646, January 2, 1971. Available at: http://www.fhwa.dot.gov/realestate/ua/uraguide3805.pdf

### 6.5.1 Methodology

This section provides a summary of the methods used to identify the potential impacts related to vehicular transportation, pedestrians, bicycles, public transportation, and parking.

#### Vehicular Transportation

Methods used for this study followed standard transportation planning industry practice for the evaluation of transportation systems and infrastructure. Much of the evaluation was based on 2015 and 2030 traffic forecasts with and without the Proposed Action. CTPS used its regional travel demand model to provide the traffic forecasts for this study. CTPS works with the communities within the Boston metropolitan region to address issues such as transportation, land use, and economic development.

CTPS's method of travel demand forecasting follows the traditional four steps of trip generation, trip distribution, modal split, and travel assignment. CTPS's *EMME/2* model uses changes in population, households, employed residents, total automobiles, and total employment to forecast changes in traffic over time. Section 4.2, *Ridership Methodology*, of this EA summarizes the methods used to forecast travel demand. Key points of the forecasting method are summarized below:

- As a starting point, CTPS's regional travel demand model was calibrated to 2008 conditions using the existing condition assessment presented in Section 5.6, *Traffic,* of this EA. This produced an existing baseline condition in the model that approximates empirical traffic counts and traffic operations.
- Future No-Build Alternative (2015 and 2030) model runs were prepared based on the forecasted changes in population, households, employed residents, and total automobiles. The model was also updated to reflect anticipated changes to the transportation infrastructure including highway and transit projects on the TIP, long-range regional plans, and proposed improvements along Monsignor O'Brien Highway associated with the NorthPoint development. A list of specific projects included is provided in Section 5.2.4, *Land Use Plans,* of this EA.
- Using the future 2015 and 2030 No-Build Alternative model runs, weekday morning and evening peak hour turning movement volume networks were created. The resulting peak hour volumes were used in a traffic operations model to evaluate how well the future infrastructure would accommodate the demands placed on it during the morning and evening peak periods. The model assigns a LOS rating to each facility analyzed that is similar to a report card – LOS A (under capacity, little delay) to LOS F (over capacity, excessive delays). This traffic operations analysis, or LOS evaluation, is consistent with the Highway Capacity Manual (HCM) which is the industry-wide guideline for transportation assessments. The LOS assessment was prepared for all project study area intersections.
- Future 2015 and 2030 Proposed Action model runs were prepared by including the extended Green Line as a mode choice and quantifying the number of vehicle

trips expected to change mode from passenger car to transit service. The Proposed Action model runs also include a determination of the number of pickup/drop-off and Park and Ride trips (where appropriate) that can be expected. Using the 2015 and 2030 Proposed Action model runs, peak hour turning movement volumes were developed for each analysis year.

- The peak hour volumes were then used to conduct LOS assessments for the 2015 and 2030 Proposed Action conditions. When compared to the No-Build Alternative, the LOS assessment for the Proposed Action condition would show the effects of the Proposed Action, both positive and adverse.
- Measures to improve conditions and avoid or minimize impacts on the transportation network were identified and evaluated for effectiveness.
- Where impacts could not be avoided or minimized, mitigation measures were developed and evaluated for effectiveness. Mitigation measures are proposed for intersections where LOS E/F conditions resulted because of the Proposed Action and where LOS E/F conditions under the No-Build Alternative were notably worsened (generally an increase in control delay of more than 10 seconds).

As described in Section 5.6.5, *Traffic Operations Analysis*, LOS is based on delay at signalized and unsignalized intersections. The criteria established to define LOS is provided in Table 5.6-3.

## Pedestrians

The travel demand model was also used to determine pedestrian patterns throughout the project study area as they relate to the Proposed Action. For each TAZ within the regional model, the CTPS was able to provide the number of pedestrians using transit and the specific station they would access. Each pathway of travel was mapped and pedestrians were accordingly assigned to routes. A pedestrian LOS analysis was completed to determine the expected delay to pedestrians at project study area intersections (*i.e.*, how long a pedestrian has to wait at a traffic signal before getting a "Walk" indication to cross the street). For signalized intersections, pedestrian LOS is based on traffic signal timings. At unsignalized intersections, where motorists are required to yield the right-of-way to pedestrians in a crosswalk, pedestrian delays are expected to be minor and are not quantified. Pedestrian volume and travel patterns for the 2015 and 2030 model runs were essentially the same; with slightly fewer pedestrians noted in 2015. To present a more conservative analysis of project impacts, only the 2030 pedestrian volumes were analyzed. Any mitigation measures required to support pedestrian access to stations would be constructed as part of the Proposed Action prior to starting service.

A secondary analysis was completed to determine whether sufficient crossing times were provided at traffic signals (*i.e.*, whether or not there is enough time provided for the pedestrian to physically cross the street before the flashing "Don't Walk" signal ends); whether existing crosswalks were sufficient to accommodate projected pedestrian volumes and travel patterns; and whether the Proposed Action would be likely to result in an adverse impact to pedestrians. Pedestrian volume networks for the Proposed Action are provided in Appendix D, *Transportation Analysis*.

## Bicycles

The impacts to bicycle transportation by the Proposed Action were evaluated by comparing the existing and potential future bicycle facilities in the vicinity of the proposed stations. Bicycle parking demand at the proposed stations was estimated based on the ridership for the stations and 2000 U.S. Census data on bicycle commuting for Cambridge, Somerville, and Medford. Bicycle accommodations were evaluated qualitatively with respect to their ability to meet demand and their sensitivity to project-related traffic volumes and roadway improvements.

## Parking

The parking assessment methodology includes two components. The first identifies the number of parking spaces that would be removed from the project study area in support of the Proposed Action. The reason for the parking reduction, whether to support construction (temporary) or needed traffic mitigation measures (permanent), is also identified.

The second component quantifies the number of unrestricted parking spaces within the vicinity of each proposed station. The likelihood of available parking spaces to be used by Green Line patrons is assessed and, as necessary, mitigation measures to discourage this practice are identified.

## Public Bus Transportation

The CTPS conducted a study to evaluate the demand on existing bus routes that could be affected by the Green Line Extension project. This evaluation is inherent in the model methodology and determined that no routes would have a majority of their ridership lost due to the project to the extent that route elimination would be warranted. Although some routes would see a reduction in ridership due to the project, these same routes would experience an increase in ridership due to their function as feeder buses to new Green Line stations. An option of truncating Bus Routes 80, 87, and 88 at Green Line stations was evaluated and found to be unfavorable. Existing bus services are proposed to remain within the project study area. However, the relocation of Lechmere Station would require minor modifications to some routes.

## 6.5.2 Environmental Consequences

The Proposed Action's direct impacts to traffic could include altered traffic demands from changes in the roadway system or increased traffic demands that result from the volume of pickup/drop-off traffic at the station locations. Indirect impacts include induced traffic shifts from other roadways to access stations because of the modified roadway network.

Once individual impacts are identified, cumulative impacts can also be discussed. Since the CTPS model was used to forecast traffic for the No-Build Alternative and Proposed Action conditions, direct, indirect, and cumulative effects are inherently incorporated in the analyses.

The Proposed Action is expected to have temporary impacts resulting from construction. Construction impacts are expected to terminate when construction is complete, and usually consist of temporary road and sidewalk closures and detours.

### No-Build Alternative

This section describes the transportation infrastructure and operations if the Proposed Action is not constructed. The impacts of the Proposed Action are determined by comparing the No-Build Alternative to the Proposed Action condition.

The No-Build Alternative assumes planned or on-going physical and operational changes would occur to the transportation system between 2008, 2015, and 2030. The travel demand model assumes most of the identified changes below are complete by 2015. This assumption is based on information provided by the cities of Medford, Somerville, and Cambridge to the Boston MPO. These changes are listed below:

#### Physical Changes

- Reconstructing Monsignor O'Brien Highway in Cambridge from near Canal Park north to Third Street. (Phased to support the interim Lechmere Station busway prior to the full build of the NorthPoint development project).
- Converting Prospect Street from one-way northbound to accommodate two-way traffic. The City of Somerville has not finalized plans to complete this conversion; the potential effects of the two-way traffic were discussed in Section 6.5.1, *Methodology*. However, the analysis assumes that Prospect Street remains one-way.

#### Operational Changes

- Changes in traffic demands attributed to forecast changes in population, households, and employment.

- Changes in traffic demands attributed to the following specific planned/permitted projects:
  - **Cambridge – NorthPoint Mixed Use Development**, approximately 5.5 million square feet of mixed use development located on Monsignor O'Brien Highway, including 2.1 million square feet of office/research development, 0.165 million square feet of retail/hotel and 2,700 residential units.
  - **Cambridge – Archstone-Smith Residential Development**, 863 apartment units located at Monsignor O'Brien Highway and East Street.
  - **Cambridge – One First Street**, 10,000 square feet of retail and office space and 209 residential units located on First Street and Otis Street.
  - **Cambridge – 22 Water Street**, 392 residential units located on Water Street.
  - **Somerville – MaxPac Square,** 199 residential units on Clyde Street and Lowell Street.
  - **Somerville – Brickbottom Redevelopment**, Rezoning to a mix-used area. These plans are still in the preliminary stage with no estimate of square footage, building height, or land use available.
  - **Somerville – Union Square Redevelopment**, Rezoning Washington Street to a mix-use area. These plans are still in the preliminary stage with no estimate of building usage available.
  - **Medford – Tufts University Master Plan**, Tufts University has indicated that current Master Planning efforts do not involve an increase in students, faculty, or staff. While the Master Plan is included, no additional traffic demand is anticipated as part of the No-Build Alternative.

Communities surrounding the project study area were also contacted. However, none of the changes planned in surrounding communities are expected to affect traffic operations within the project study area.

The specific information provided by each community was reviewed against the population, household, and employment data considered in the CTPS travel demand model for 2015 and 2030. All noted projects are included in both model conditions as appropriate. The No-Build Alternative traffic volume networks are presented in Appendix D, *Transportation Analysis*.

### No-Build Alternative Traffic Operations (2015)

The results of the traffic operations analysis are presented in Table 6.5-1 for signalized intersections and Table 6.5-2 for unsignalized intersections. Complete LOS results for all intersections are provided in Appendix D, *Transportation Analysis*. As discussed in Section 5.6.1, *Traffic Study Intersections*, 11 signalized intersections and 10 unsignalized intersections operate at an unacceptable LOS during at least one peak hour in 2008. By 2015, 18 signalized intersections and 11 unsignalized intersections are expected to operate at unacceptable LOS E or LOS F. It should be noted that observed traffic volumes at the majority of existing unsignalized intersections far exceed the physical capacity of the intersections.

## Table 6.5-1 No-Build Alternative Signalized Intersection Traffic Operations (2015)

| | Existing Condition | | | | | | 2015 No-Build Alternative | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Morning Peak Hour | | | Evening Peak Hour | | | Morning Peak Hour | | | Evening Peak Hour | | |
| Intersection | V/C[1] | Delay[2] | LOS[3] | V/C | Delay | LOS | V/C | Delay | LOS | V/C | Delay | LOS |
| Mystic Valley Pkwy at Boston Avenue | 0.93 | 61 | E | 1.06 | 82 | F | 1.00 | 74 | E | 1.16 | 102 | F |
| Mystic Valley Pkwy at Auburn Street (East) | 0.81 | 33 | C | 0.79 | 35 | D | 0.87 | 47 | D | 0.82 | 39 | D |
| Mystic Valley Pkwy at Auburn (West) | 0.68 | 11 | B | 0.64 | 26 | C | 0.74 | 12 | B | 0.68 | 32 | C |
| Mystic Valley Pkwy at Winthrop Street | >1.2 | >120 | F | > 1.2 | >120 | F | >1.2 | >120 | F | >1.2 | >120 | F |
| Boston Avenue at North Street | 0.52 | 17 | B | 0.39 | 16 | B | 0.55 | 18 | B | 0.42 | 16 | B |
| Boston Avenue at Winthrop Street | 1.00 | 46 | D | 0.99 | 55 | D | 1.07 | 59 | E | 1.08 | 71 | E |
| Boston Avenue at College Avenue | 0.92 | 55 | D | 0.86 | 47 | D | 0.97 | 70 | E | 0.93 | 58 | E |
| Boston Avenue at Harvard Street/Warner Street | 0.74 | 20 | B | 0.74 | 19 | B | 0.78 | 20 | C | 1.01 | 40 | D |
| Broadway at Boston Avenue (Ball Square) | 0.81 | 30 | C | 0.64 | 12 | B | 0.91 | 26 | C | 0.71 | 15 | B |
| College Avenue at Powder House Blvd/Broadway/Warner Street (East Side) | 0.52 | 2 | A | 0.60 | 2 | A | 0.61 | 2 | A | 0.54 | 2 | A |
| College Avenue at Powder House Blvd/Broadway/Warner Street (West Side) | 0.70 | 4 | A | 0.58 | 2 | A | 0.89 | 10 | B | 0.60 | 2 | A |
| Main Street at High Street/Salem Street/Forest Avenue/Riverside Avenue | 0.95 | 57 | E | 0.74 | 32 | C | 1.13 | 102 | F | 0.81 | 36 | D |
| Main Street at Clipper Ship Drive | 0.61 | 1 | A | 0.52 | 4 | A | 0.79 | 1 | A | 0.68 | 5 | A |
| Main Street at Harvard Street | 1.09 | 79 | E | 1.12 | 80 | E | >1.2 | >120 | F | >1.2 | >120 | F |
| Broadway at Medford Street/Dexter Street | 0.96 | 68 | E | 0.85 | 47 | D | 1.07 | 86 | F | 0.95 | 83 | F |
| Medford Street at Central Street | 0.71 | 20 | C | 0.64 | 20 | C | 0.76 | 23 | C | 0.73 | 24 | C |
| Medford Street at School Street | 0.87 | 26 | C | 0.83 | 29 | C | 1.01 | 47 | D | 0.97 | 63 | E |
| Medford Street at Walnut Street | 0.51 | 17 | B | 0.51 | 16 | B | 0.57 | 20 | B | 0.58 | 17 | B |
| Medford Street at Highland Avenue | 0.88 | 41 | D | 0.60 | 14 | B | 0.96 | 61 | E | 0.72 | 18 | B |
| Medford Street at Somerville Avenue/McGrath Hwy | 0.70 | 34 | C | 0.65 | 33 | C | 0.81 | 45 | D | 0.74 | 36 | D |
| Highland Avenue at Lowell Street | 0.64 | 17 | B | 0.50 | 12 | B | 0.66 | 17 | B | 0.52 | 12 | B |
| Highland Avenue at Central Street | 0.62 | 16 | B | 0.68 | 17 | B | 0.63 | 16 | B | 0.73 | 20 | B |
| Highland Avenue at School Street | 0.79 | 30 | C | 0.75 | 25 | C | 0.82 | 31 | C | 0.80 | 27 | C |
| Washington Street at McGrath Hwy (East) | 0.54 | 27 | C | 0.74 | 117 | F | 0.68 | 37 | D | 0.87 | >120 | F |
| Washington Street at McGrath Hwy (West) | 0.66 | 200 | F | 0.57 | 103 | F | 0.82 | >120 | F | 0.66 | >120 | F |
| Washington Street at Inner Belt Road | 0.63 | 9 | A | 0.72 | 14 | B | 1.04 | 55 | E | 0.78 | 16 | B |
| Prospect Street at Somerville Avenue | 0.89 | 67 | E | 0.94 | 65 | E | 1.08 | >120 | F | 1.01 | 70 | E |
| Washington Street at Somerville Avenue/Webster Street | 0.85 | 38 | D | 0.79 | 38 | D | 1.03 | 62 | E | 0.89 | 50 | D |
| Washington Street at Beacon Street/Kirkland Street | 0.84 | 32 | C | 0.80 | 27 | C | 0.88 | 40 | D | 0.83 | 29 | C |
| Prospect Street at Webster Street/Concord Avenue | 0.71 | 30 | C | 1.19 | 136 | F | 1.05 | 107 | F | >1.2 | >120 | F |
| Prospect Street at Cambridge Street | 0.59 | 22 | C | 0.79 | 29 | C | 0.70 | 26 | C | 0.96 | 44 | D |
| Prospect Street at Hampshire Street | 0.64 | 27 | C | 0.56 | 25 | C | 0.77 | 44 | D | 0.67 | 28 | C |
| Monsignor O'Brien Highway at Land Boulevard/Gilmore Bridge | 1.17 | >120 | F | 1.16 | >120 | F | >1.2 | >120 | F | >1.2 | >120 | F |
| Monsignor O'Brien Highway at Third Street | 0.69 | 18 | B | 0.95 | >120 | F | 1.09 | >120 | F | >1.2 | >120 | F |
| Monsignor O'Brien Highway at Museum Way | 0.72 | 11 | B | 0.60 | 11 | B | 0.87 | 35 | D | 0.80 | 28 | C |
| Cambridge Street at First Street | 0.48 | 16 | B | 0.48 | 18 | B | 0.72 | 28 | C | 0.81 | 63 | E |
| Monsignor O'Brien Highway at North First Street | Does not exist currently | | | | | | 0.86 | 32 | C | 0.85 | 52 | D |
| Monsignor O'Brien Highway at Water Street | Unsignalized currently | | | | | | 0.72 | 14 | B | 0.60 | 16 | B |

1 Volume-to-capacity ratio
2 Average delay expressed in seconds per vehicle
3 Level-of-Service

## Table 6.5-2 No-Build Alternative Unsignalized Intersection Traffic Operations (2015)

| | | Existing Condition | | | | | | 2015 No-Build Alternative | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Morning Peak Hour | | | Evening Peak Hour | | | Morning Peak Hour | | | Evening Peak Hour | | |
| Intersection | Critical Movement | V/C[1] | Delay[2] | LOS[3] | V/C | Delay | LOS | V/C[1] | Delay[2] | LOS[3] | V/C | Delay | LOS |
| Boston Avenue at High Street/ Sagamore Avenue | Boston Street Northbound | >1.2 | >120 | F | >1.2 | >120 | F | >1.2 | >60 | F | >1.2 | >60 | F |
| College Avenue at George Street | George Street Westbound | 0.74 | 17 | C | 0.82 | 21 | C | 0.90 | 37 | E | 0.92 | 42 | E |
| Main Street at George Street | George Street Eastbound | >1.2 | >120 | F | >1.2 | >120 | F | >1.2 | >60 | F | >1.2 | >60 | F |
| Main Street at Mystic Avenue/Fire Station | Main Street Eastbound | >1.2 | >120 | F | >1.2 | >120 | F | >1.2 | >60 | F | >1.2 | >60 | F |
| Main Street at South Street/Mystic Valley Pkwy Eastbound Ramps | South Street Eastbound | >1.2 | >120 | F | >1.2 | >120 | F | >1.2 | >60 | F | >1.2 | >60 | F |
| Main Street at Mystic Valley Pkwy Westbound Ramps | Mystic Valley Pkwy Westbound Ramps | >1.2 | >120 | F | >1.2 | >120 | F | >1.2 | >60 | F | >1.2 | >60 | F |
| Medford Street at Lowell Street | Lowell Street Northbound | 1.02 | >120 | F | 0.32 | 18 | C | >1.2 | >60 | F | 0.38 | 21 | C |
| Medford Street at Pearl Street | Pearl Street Westbound | 0.96 | 74 | F | 0.70 | 26 | D | >1.2 | >60 | F | 0.88 | 47 | E |
| Broadway at Winchester Street/Albion Street | Winchester/Albion Southbound | >1.2 | >120 | F | 0.79 | 87 | F | >1.2 | >60 | F | 1.03 | >60 | F |
| Monsignor O'Brien Highway at Gore Street | Gore Street Northbound | 0.07 | 10 | A | 0.08 | 10 | A | 0.04 | 10 | A | 0.13 | 10 | B |
| Monsignor O'Brien Highway at East Street/ Cambridge Street | Cambridge Street Eastbound | 0.03 | 9 | A | 0.02 | 11 | B | 0.46 | 14 | B | 0.88 | 31 | D |
| Washington Street at Joy Street | Joy Street Northbound | >1.2 | >120 | F | >1.2 | >120 | F | >1.2 | >120 | F | >1.2 | >120 | F |
| Washington Street at Tufts Street/ Knowlton Street | Tufts Street Southbound | >1.2 | >120 | F | >1.2 | >120 | F | >1.2 | >120 | F | >1.2 | >120 | F |
| **Roundabout** | | | | | | | | | | | | | |
| Mystic Valley Pkwy at Alewife Brook Pkwy | -- | 1.02 | 34 | C | 1.13 | 43 | D | >1.2 | 50 | D | 1.00 | 23 | C |

1 Volume to capacity ratio
2 Average delay expressed in seconds per vehicle
3 Level-of-Service

### No-Build Alternative Traffic Operations (2030)

The results of the traffic operations analysis for the 2030 No-Build Alternative are presented in Table 6.5-3 for signalized intersections and Table 6.5-4 for unsignalized intersections. Complete LOS results for all intersections are provided in Appendix D, *Transportation Analysis*.

- By 2030, 17 signalized intersections and 11 unsignalized intersections are expected to operate at unacceptable LOS E or LOS F. Similar to the existing and 2015 No-Build Conditions, traffic volumes at the majority of existing unsignalized intersections far exceed the physical capacity of the intersections.

## Table 6.5-3 No-Build Alternative Signalized Intersection Traffic Operations (2030)

| | Existing Condition | | | | | | 2030 No-Build Alternative | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Morning Peak Hour | | | Evening Peak Hour | | | Morning Peak Hour | | | Evening Peak Hour | | |
| Intersection | V/C[1] | Delay[2] | LOS[3] | V/C | Delay | LOS | V/C | Delay | LOS | V/C | Delay | LOS |
| Mystic Valley Pkwy at Boston Avenue | 0.93 | 61 | E | 1.06 | 82 | F | 1.03 | 81 | F | >1.2 | 111 | F |
| Mystic Valley Pkwy at Auburn Street (East) | 0.81 | 33 | C | 0.79 | 35 | D | 0.88 | 48 | D | 0.84 | 44 | D |
| Mystic Valley Pkwy at Auburn (West) | 0.68 | 11 | B | 0.64 | 26 | C | 0.75 | 12 | B | 0.70 | 35 | C |
| Mystic Valley Pkwy at Winthrop Street | >1.2 | >120 | F | > 1.2 | >120 | F | >1.2 | >120 | F | >1.2 | >120 | F |
| Boston Avenue at North Street | 0.52 | 17 | B | 0.39 | 16 | B | 0.56 | 18 | B | 0.43 | 17 | B |
| Boston Avenue at Winthrop Street | 1.00 | 46 | D | 0.99 | 55 | D | 1.10 | 65 | E | 1.09 | 75 | E |
| Boston Avenue at College Avenue | 0.92 | 55 | D | 0.86 | 47 | D | 0.98 | 71 | E | 0.94 | 60 | E |
| Boston Avenue at Harvard Street/Warner Street | 0.74 | 20 | B | 0.74 | 19 | B | 0.78 | 21 | C | 1.03 | 43 | D |
| Broadway at Boston Avenue (Ball Square) | 0.81 | 30 | C | 0.64 | 12 | B | 0.91 | 27 | C | 0.72 | 15 | B |
| College Avenue at Powder House Blvd/Broadway/Warner Street (East Side) | 0.52 | 2 | A | 0.60 | 2 | A | 0.63 | 2 | A | 0.56 | 2 | A |
| College Avenue at Powder House Blvd/Broadway/ Warner Street (West Side) | 0.70 | 4 | A | 0.58 | 2 | A | 0.91 | 13 | B | 0.62 | 2 | A |
| Main Street at High Street/Salem Street/Forest Avenue/Riverside Avenue | 0.95 | 57 | E | 0.74 | 32 | C | 1.14 | 104 | F | 0.82 | 37 | D |
| Main Street at Clipper Ship Drive | 0.61 | 1 | A | 0.52 | 4 | A | 0.79 | 1 | A | 0.69 | 5 | A |
| Main Street at Harvard Street | 1.09 | 79 | E | 1.12 | 80 | E | >1.2 | >120 | F | >1.2 | >120 | F |
| Broadway at Medford Street/Dexter Street | 0.96 | 68 | E | 0.85 | 47 | D | 1.1.4 | 104 | F | 1.01 | 104 | F |
| Medford Street at Central Street | 0.71 | 20 | C | 0.64 | 20 | C | 0.78 | 24 | C | 0.76 | 26 | C |
| Medford Street at School Street | 0.87 | 26 | C | 0.83 | 29 | C | 1.05 | 55 | E | 1.00 | 73 | E |
| Medford Street at Walnut Street | 0.51 | 17 | B | 0.51 | 16 | B | 0.58 | 20 | C | 0.60 | 18 | B |
| Medford Street at Highland Avenue | 0.88 | 41 | D | 0.60 | 14 | B | 0.99 | 66 | E | 0.73 | 20 | C |
| Medford Street at Somerville Avenue/McGrath Hwy | 0.70 | 34 | C | 0.65 | 33 | C | 0.83 | 49 | D | 0.76 | 37 | D |
| Highland Avenue at Lowell Street | 0.64 | 17 | B | 0.50 | 12 | B | 0.67 | 17 | B | 0.53 | 12 | B |
| Highland Avenue at Central Street | 0.62 | 16 | B | 0.68 | 17 | B | 0.65 | 17 | B | 0.74 | 21 | C |
| Highland Avenue at School Street | 0.79 | 30 | C | 0.75 | 25 | C | 0.86 | 33 | C | 0.83 | 29 | C |
| Washington Street at McGrath Hwy (East) | 0.54 | 27 | C | 0.74 | 117 | F | 0.70 | 39 | D | 0.89 | >120 | F |
| Washington Street at McGrath Hwy (West) | 0.66 | 200 | F | 0.57 | 103 | F | 0.84 | >120 | F | 0.68 | >120 | F |
| Washington Street at Inner Belt Road | 0.63 | 9 | A | 0.72 | 14 | B | 1.07 | 61 | E | 0.80 | 17 | B |
| Prospect Street at Somerville Avenue | 0.89 | 67 | E | 0.94 | 65 | E | 1.11 | >120 | F | 1.04 | 75 | E |
| Washington Street at Somerville Avenue/Webster Street | 0.85 | 38 | D | 0.79 | 38 | D | 1.06 | 67 | E | 0.91 | 54 | D |
| Washington Street at Beacon Street/Kirkland Street | 0.84 | 32 | C | 0.80 | 27 | C | 0.90 | 44 | D | 0.86 | 31 | C |
| Prospect Street at Webster Street/Concord Avenue | 0.71 | 30 | C | 1.19 | 136 | F | 1.08 | 117 | F | >1.2 | >120 | F |
| Prospect Street at Cambridge Street | 0.59 | 22 | C | 0.79 | 29 | C | 0.72 | 26 | C | 0.99 | 49 | D |
| Prospect Street at Hampshire Street | 0.64 | 27 | C | 0.56 | 25 | C | 0.78 | 49 | D | 0.68 | 27 | C |
| Monsignor O'Brien Highway at Land Boulevard/ Gilmore Bridge | 1.17 | >120 | F | 1.16 | >120 | F | >1.2 | >120 | F | >1.2 | >120 | F |
| Monsignor O'Brien Highway at Third Street | 0.69 | 18 | B | 0.95 | >120 | F | 1.15 | >120 | F | >1.2 | >120 | F |
| Monsignor O'Brien Highway at Museum Way | 0.72 | 11 | B | 0.60 | 11 | B | 0.87 | 35 | D | 0.8 | 28 | C |
| Cambridge Street at First Street | 0.48 | 16 | B | 0.48 | 18 | B | 0.57 | 23 | C | 0.66 | 49 | D |
| Monsignor O'Brien Highway at North First Street | Does not exist in existing condition | | | | | | 0.86 | 32 | C | 0.85 | 52 | D |
| Monsignor O'Brien Highway at Water Street | Unsignalized in existing condition | | | | | | 0.72 | 14 | B | 0.60 | 16 | B |

1 Volume-to-capacity ratio
2 Average delay expressed in seconds per vehicle
3 Level-of-Service

### Table 6.5-4 No-Build Alternative Unsignalized Intersection Traffic Operations (2030)

| | | Existing Condition | | | | | | 2030 No-Build Alternative | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Morning Peak Hour | | | Evening Peak Hour | | | Morning Peak Hour | | | Evening Peak Hour | | |
| **Intersection** | **Critical Movement** | V/C[1] | Delay[2] | LOS[3] | V/C | Delay | LOS | V/C | Delay | LOS | V/C | Delay | LOS |
| Boston Avenue at High Street/Sagamore Avenue | High Street Northbound | >1.2 | >120 | F | >1.2 | >120 | F | >1.2 | >60 | F | >1.2 | >60 | F |
| College Avenue at George Street | George Street Westbound | 0.74 | 17 | C | 0.82 | 21 | C | 0.90 | 38 | E | 0.92 | 41 | E |
| Main Street at George Street | George Street Eastbound | >1.2 | >120 | F | >1.2 | >120 | F | >1.2 | >60 | F | >1.2 | >60 | F |
| Main Street at Mystic Avenue/ Fire Station | Main Street Eastbound | >1.2 | >120 | F | >1.2 | >120 | F | >1.2 | >60 | F | >1.2 | >60 | F |
| Main Street at South Street/Mystic Valley Pkwy Eastbound Ramps | South Street Eastbound | >1.2 | >120 | F | >1.2 | >120 | F | >1.2 | >60 | F | >1.2 | >60 | F |
| Main Street at Mystic Valley Pkwy Westbound Ramps | Mystic Valley Pkwy Westbound Ramps | >1.2 | >120 | F | >1.2 | >120 | F | >1.2 | >60 | F | >1.2 | >60 | F |
| Medford Street at Lowell Street | Lowell Street Northbound | 1.02 | >120 | F | 0.32 | 18 | C | >1.2 | >60 | F | 0.41 | 22 | C |
| Medford Street at Pearl Street | Pearl Street Westbound | 0.96 | 74 | F | 0.70 | 26 | D | >1.2 | >60 | F | 0.93 | 56 | F |
| Broadway at Winchester Street/ Albion Street | Winchester/Albion Southbound | >1.2 | >120 | F | 0.79 | 87 | F | >1.2 | >60 | F | 1.03 | >60 | F |
| Monsignor O'Brien Highway at Gore Street | Gore Street Northbound | 0.07 | 10 | A | 0.08 | 10 | A | 0.42 | 10 | A | 0.13 | 10 | B |
| Monsignor O'Brien Highway at East Street/ Cambridge Street | Cambridge Street Eastbound | 0.03 | 9 | A | 0.02 | 11 | B | 0.46 | 14 | B | 0.88 | 31 | D |
| Washington Street at Joy Street | Joy Street Northbound | >1.2 | >120 | F | >1.2 | >120 | F | >1.2 | >120 | F | >1.2 | >120 | F |
| Washington Street at Tufts Street/ Knowlton Street | Tufts Street Southbound | >1.2 | >120 | F | >1.2 | >120 | F | >1.2 | >120 | F | >1.2 | >120 | F |
| **Roundabout** | | | | | | | | | | | | | |
| Mystic Valley Pkwy at Alewife Brook Pkwy | -- | 1.02 | 34 | C | 1.13 | 43 | D | >1.2 | 55 | D | 0.98 | 22 | C |

1 Volume-to-capacity ratio
2 Average delay expressed in seconds per vehicle
3 Level-of-Service

## Pedestrians

Pedestrian LOS at signalized intersections is a function of the traffic signal timing and phasing. Because No-Build Alternative traffic signal timing and phasing is assumed unchanged from existing conditions, pedestrian LOS would remain the same as presented previously in Table 5.6-6. Seventeen signalized intersections exhibit poor pedestrian LOS at one or more crosswalks.

As discussed in Section 5.6, *Traffic*, 18 signalized intersections do not currently provide sufficient crossing times for pedestrians. This would continue in 2015 and 2030 if no changes are made to the traffic signals.

## Bicycles

The No-Build Alternative would not physically alter existing designated bicycle facilities nor preclude the construction of on-road or off-road facilities that are proposed for the project study area in the future. The proposed Somerville Community Path is assumed to be complete between 2015 and 2030. Bicycle accommodations would likely expand in 2015 and 2030, with travel along routes that offer exclusive bicycle lanes seeing an increase in bicycle traffic. Along routes where no exclusive bicycle accommodation is provided, bicycle travel would become more difficult as traffic volumes increase.

### Parking

The No-Build Alternative would not physically alter existing parking supply or a community's ability to expand parking or change enforcement. As traffic volumes increase, it is expected that the availability of unrestricted parking spaces would decrease, particularly in the vicinity of College Avenue and Lechmere Station where occupancy is currently high throughout the day.

### Bus Transportation

There would be no change to public transportation systems under the No-Build Alternative.

## Union Square Roadway Changes

The City of Somerville is currently studying several roadway improvement alternatives for Union Square. These proposed changes would affect vehicle, pedestrian, and bicycle operations related to Union Square Station only.

The City's preferred alternative includes the conversion of Webster Avenue and Prospect Street from a one-way pair to two-way streets. Webster Avenue would be modified from one-way southbound to a two-way street between Prospect Street and Somerville Avenue. Prospect Street would be converted from one-way northbound to a two-way street between Webster Avenue and Somerville Avenue in Union Square. Washington Street would be extended west through an existing parking lot. The Washington Street extension would allow for two-way travel and would become the westbound leg at the intersection of Somerville Avenue/Bow Street at Webster Avenue. The existing section of Somerville Avenue between Bow Street/Webster Avenue and Washington Street would be converted to a one-way eastbound street where pedestrians and bicyclists would have the right-of-way. This type of roadway treatment is referred to as a "woonerf" and is prevalent in the Netherlands. A figure depicting the proposed changes is provided in Appendix D, *Transportation Analysis*.

A review of how traffic volumes might shift based on this new roadway pattern indicates that LOS at three intersections could be improved:

- Washington Street at Somerville Avenue/Webster Street;
- Prospect Street at Somerville Avenue; and
- Prospect Street at Webster Street/Concord Avenue.

The Green Line Extension project would not present an adverse impact on these three locations regardless of whether or not the roadway changes are made by the City. However, traffic circulation to and from the proposed Union Square Station (which would be located on Prospect Street) would be improved if Prospect Street were bi-directional. For example, southbound traffic would be able to access Prospect Street directly and then continue south. Under the existing condition, this traffic would travel south on Webster Street, north on Prospect Street for passenger pickup/drop-off, and then south on Webster Street again to continue to their destination. The basis of this traffic analysis assumes that Prospect Street remains one-way. However, there would be no substantial traffic differences (with respect to the Proposed Action) between the one-way and two-way scenarios.

## Proposed Action (2015)

Table 6.5-5 presents the expected peak hour Green Line ridership under the Proposed Action (2015) and how riders are likely to access each station. Traffic volume networks for 2015 are presented in Appendix D, *Transportation Analysis*.

**Table 6.5-5 Proposed Action Trip Summary by Station (2015)**

| Green Line Station | | Boardings | Park and Ride[1] | Pickup/ Drop-off | Transfer | Walk | Bike[2] |
|---|---|---|---|---|---|---|---|
| Lechmere | Daily | 7,930 | 200 | 255 | 430 | 6,650 | 395 |
| | Peak Hour | 1,760 | 180 | 90 | 430 | 965 | 95 |
| Washington Street | Daily | 2,380 | 0 | 145 | 95 | 2,020 | 120 |
| | Peak Hour | 660 | 0 | 50 | 95 | 475 | 40 |
| Gilman Square | Daily | 3,950 | 0 | 215 | 10 | 3,525 | 200 |
| | Peak Hour | 1,540 | 0 | 75 | 10 | 1,375 | 80 |
| Lowell Street | Daily | 1,070 | 0 | 55 | 0 | 960 | 55 |
| | Peak Hour | 450 | 0 | 20 | 0 | 400 | 30 |
| Ball Square | Daily | 1,760 | 0 | 115 | 100 | 1,455 | 90 |
| | Peak Hour | 720 | 0 | 40 | 100 | 540 | 40 |
| College Avenue | Daily | 2,000 | 0 | 115 | 365 | 1,420 | 100 |
| | Peak Hour | 700 | 0 | 40 | 365 | 255 | 40 |
| Union Square | Daily | 3,260 | 0 | 185 | 5 | 2,905 | 165 |
| | Peak Hour | 1,140 | 0 | 65 | 5 | 1,010 | 60 |

1 Lechmere parking supply exists currently. No proposed new spaces are associated with the Proposed Action at the relocated Lechmere Station.
2 Based on 2000 Census data and bicycle mode split in each community.

### Traffic Operations

As seen in Table 6.5-6, 14 signalized intersections would continue to operate at unacceptable LOS under the Proposed Action (2015) during at least one peak hour. Intersections where LOS would improve due to the optimized signal timing and phasing assumed under the Proposed Action are denoted in *italics* and underlined. Intersections where LOS would degrade under the Proposed Action are indicated in **bold**.

## Table 6.5-6 Proposed Action Signalized Intersection Traffic Operations (2015)

| | 2015 No-Build Alternative | | | | | | 2015 Proposed Action | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Morning Peak Hour | | | Evening Peak Hour | | | Morning Peak Hour | | | Evening Peak Hour | | |
| Intersection | V/C[1] | Delay[2] | LOS[3] | V/C | Delay | LOS | V/C | Delay | LOS | V/C | Delay | LOS |
| Mystic Valley Pkwy at Boston Avenue | 1.00 | 74 | E | 1.16 | 102 | F | 1.00 | 58 | E | 1.20 | 87 | F |
| Mystic Valley Pkwy at Auburn Street (East) | 0.87 | 47 | D | 0.82 | 39 | D | *0.89* | *20* | *B* | *0.88* | *21* | *C* |
| Mystic Valley Pkwy at Auburn (West) | 0.74 | 12 | B | 0.68 | 32 | C | *0.77* | *8* | *A* | *0.70* | *19* | *B* |
| Mystic Valley Pkwy at Winthrop Street | >1.2 | >120 | F | >1.2 | >120 | F | >1.2 | >120 | F | >1.2 | >120 | F |
| Boston Avenue at North Street | 0.55 | 18 | B | 0.42 | 16 | B | 0.59 | 14 | B | 0.45 | 12 | B |
| Boston Avenue at Winthrop Street | 1.07 | 59 | E | 1.08 | 71 | E | 1.05 | 62 | E | 1.09 | 74 | E |
| Boston Avenue at College Avenue | 0.97 | 70 | E | 0.93 | 58 | E | 0.99 | 70 | E | 0.90 | 56 | E |
| Boston Avenue at Harvard Street/Warner Street | 0.78 | 20 | C | 1.01 | 40 | D | *0.79* | *19* | *B* | 1.01 | 42 | D |
| Broadway at Boston Avenue (Ball Square) | 0.91 | 26 | C | 0.71 | 15 | B | 0.86 | 21 | C | 0.70 | 14 | B |
| College Avenue at Powder House Blvd/Broadway/Warner Street (East Side) | 0.61 | 2 | A | 0.54 | 2 | A | 0.61 | 2 | A | 0.54 | 2 | A |
| College Avenue at Powder House Blvd/Broadway/Warner Street (West Side) | 0.89 | 10 | B | 0.60 | 2 | A | 0.88 | 10 | B | 0.60 | 2 | A |
| Main Street at High Street/Salem Street/Forest Avenue/ Riverside Avenue | 1.13 | 102 | F | 0.81 | 36 | D | *1.10* | *79* | *E* | *0.80* | *30* | *C* |
| Main Street at Clipper Ship Drive | 0.79 | 1 | A | 0.68 | 5 | A | 0.85 | 2 | A | 0.68 | 5 | A |
| Main Street at Harvard Street | >1.2 | >120 | F | >1.2 | >120 | F | >1.2 | >120 | F | >1.2 | >120 | F |
| Broadway at Medford Street/Dexter Street | 1.07 | 86 | F | 0.95 | 83 | F | *1.01* | *71* | *E* | *0.91* | *49* | *D* |
| Medford Street at Central Street | 0.76 | 23 | C | 0.73 | 24 | C | 0.80 | 22 | C | 0.72 | 22 | C |
| Medford Street at School Street | 1.01 | 47 | D | 0.97 | 63 | E | 0.88 | 39 | D | *0.89* | *30* | *C* |
| Medford Street at Walnut Street | 0.57 | 20 | B | 0.58 | 17 | B | **0.61** | **20** | **C** | 0.57 | 18 | B |
| Medford Street at Highland Avenue | 0.96 | 61 | E | 0.72 | 18 | B | *0.83* | *46* | *D* | 0.63 | 15 | B |
| Medford Street at Somerville Avenue/McGrath Hwy | 0.81 | 45 | D | 0.74 | 36 | D | 0.79 | 41 | D | *0.75* | *33* | *C* |
| Highland Avenue at Lowell Street | 0.66 | 17 | B | 0.52 | 12 | B | 0.64 | 18 | B | 0.52 | 13 | B |
| Highland Avenue at Central Street | 0.63 | 16 | B | 0.73 | 20 | C | 0.62 | 16 | B | 0.73 | 20 | C |
| Highland Avenue at School Street | 0.82 | 31 | C | 0.80 | 27 | C | 0.77 | 29 | C | 0.76 | 25 | C |
| Washington Street at McGrath Hwy (East) | 0.68 | 37 | D | 0.87 | >120 | F | 0.70 | 44 | D | *0.86* | *57* | *E* |
| Washington Street at McGrath Hwy (West) | 0.82 | >120 | F | 0.66 | >120 | F | *0.82* | *48* | *D* | *0.65* | *50* | *D* |
| Washington Street at Inner Belt Road | 1.04 | 55 | E | 0.78 | 16 | B | *0.97* | *36* | *D* | 0.75 | 16 | B |
| Prospect Street at Somerville Avenue | 1.08 | >120 | F | 1.01 | 70 | E | 1.03 | 100 | F | **1.03** | **84** | **F** |
| Washington Street at Somerville Avenue/Webster Street | 1.03 | 62 | E | 0.89 | 50 | D | 1.06 | 74 | E | **0.85** | **65** | **E** |
| Washington Street at Beacon Street/Kirkland Street | 0.88 | 40 | D | 0.83 | 29 | C | 0.90 | 37 | D | 0.81 | 30 | C |
| Prospect Street at Webster Street/Concord Avenue | 1.05 | 107 | F | >1.2 | >120 | F | *0.84* | *22* | *C* | >1.2 | 90 | F |
| Prospect Street at Cambridge Street | 0.70 | 26 | C | 0.96 | 44 | D | 0.70 | 26 | C | 0.94 | 42 | D |
| Prospect Street at Hampshire Street | 0.77 | 44 | D | 0.67 | 28 | C | *0.76* | *28* | *C* | 0.65 | 27 | C |
| Monsignor O'Brien Highway at Land Boulevard/Gilmore Bridge | >1.2 | >120 | F | >1.2 | >120 | F | >1.2 | >120 | F | >1.2 | >120 | F |
| Monsignor O'Brien Highway at Third Street | 1.09 | >120 | F | >1.2 | >120 | F | 1.06 | >120 | F | >1.2 | >120 | F |
| Monsignor O'Brien Highway at Museum Way | 0.87 | 35 | D | 0.80 | 28 | C | *0.85* | *35* | *C* | 0.79 | 27 | C |
| Cambridge Street at First Street | 0.72 | 28 | C | 0.81 | 63 | E | 0.71 | 28 | C | 0.81 | 64 | E |
| Monsignor O'Brien Highway at North First Street | 0.86 | 32 | C | 0.85 | 52 | D | 0.84 | 31 | C | 0.83 | 49 | D |
| Monsignor O'Brien Highway at Water Street | 0.72 | 14 | B | 0.60 | 16 | B | 0.69 | 13 | B | 0.59 | 16 | B |

Note: Intersections improving by at least one LOS are denoted in *italics* and underlined. Intersections degrading by at least one LOS are denoted in **bold**.

1 Volume-to-capacity ratio

2 Average delay expressed in seconds per vehicle

3 Level-of-Service

Six intersections would improve from unacceptable to acceptable traffic operations during at least one peak hour under the Proposed Action:

- Broadway at Medford Street/Dexter Street (evening peak hour only);
- Medford Street at School Street (evening peak hour only);
- Medford Street at Highland Avenue (morning peak hour only);
- Washington Street at McGrath Highway West;
- Washington Street at Inner Belt Road (morning peak hour only); and
- Prospect Street at Webster Street/Concord Avenue (morning peak hour only).

An additional three intersections would improve from LOS F to LOS E during at least one peak hour:

- Main Street at High Street/Salem Street/Forest Avenue/Riverside Avenue (morning peak hour only);
- Broadway at Medford Street/Dexter Street (morning peak hour only); and
- Washington Street at McGrath Highway East (evening peak hour only).

LOS would decrease at three locations:

- Medford Street at Walnut Street (morning peak hour only);
- Prospect Street at Somerville Avenue (evening peak hour only); and
- Washington Street at Somerville Avenue/Webster Street (evening peak hour only).

For the majority of these intersections, vehicular LOS would degrade because signal timings would be adjusted to provide enough time for pedestrians to cross the street before the flashing “Don’t Walk” signal ends. Changes in vehicular LOS would be negligible if mitigation measures for pedestrians were not provided. Mitigation to offset adverse impacts is described in Section 7.3.3, *Traffic and Transportation Systems*, of this EA.

As shown in Table 6.5-7, one unsignalized intersection is expected to see an increase in delay under the Proposed Action (2015), but no change in LOS. Three unsignalized intersections are expected to see a decrease in delay under the Proposed Action (2015), but no change in LOS. The remaining intersections would continue to operate as in the No-Build Alternative.

## Table 6.5-7 Proposed Action Unsignalized Intersection Traffic Operations (2015)

| | | 2015 No-Build Alternative | | | | | | 2015 Proposed Action | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Morning Peak Hour | | | Evening Peak Hour | | | Morning Peak Hour | | | Evening Peak Hour | | |
| Intersection | Critical Movement | V/C[1] | Delay[2] | LOS[3] | V/C | Delay | LOS | V/C | Delay | LOS | V/C | Delay | LOS |
| Boston Avenue at High Street/ Sagamore Avenue | Boston Street Northbound | >1.2 | >60 | F | >1.2 | >60 | F | >1.2 | >60 | F | >1.2 | >60 | F |
| College Avenue at George Street | George Street Westbound | 0.90 | 37 | E | 0.92 | 42 | E | 0.90 | 37 | E | 0.93 | 43 | E |
| Main Street at George Street | George Street Eastbound | >1.2 | >60 | F | >1.2 | >60 | F | >1.2 | >60 | F | >1.2 | >60 | F |
| Main Street at Mystic Avenue/ Fire Station | Main Street Eastbound | >1.2 | >60 | F | >1.2 | >60 | F | >1.2 | >60 | F | >1.2 | >60 | F |
| Main Street at South Street/Mystic Valley Pkwy Eastbound Ramps | South Street Eastbound | >1.2 | >60 | F | >1.2 | >60 | F | >1.2 | >60 | F | >1.2 | >60 | F |
| Main Street at Mystic Valley Pkwy Westbound Ramps | Mystic Valley Pkwy Westbound Ramps | >1.2 | >60 | F | >1.2 | >60 | F | >1.2 | >60 | F | >1.2 | >60 | F |
| Medford Street at Lowell Street | Lowell Street Northbound | >1.2 | >60 | F | 0.38 | 21 | C | 1.18 | >60 | F | 0.39 | 21 | C |
| Medford Street at Pearl Street | Pearl Street Westbound | >1.2 | >60 | F | 0.88 | 47 | E | >1.2 | >60 | F | 0.86 | 42 | E |
| Broadway at Winchester Street/ Albion Street | Winchester/Albion Southbound | >1.2 | >60 | F | 1.03 | >60 | F | >1.2 | >60 | F | 1.00 | >60 | F |
| Monsignor O'Brien Highway at Gore Street | Gore Street Northbound | 0.04 | 10 | A | 0.13 | 10 | B | 0.04 | 10 | A | 0.13 | 10 | B |
| Monsignor O'Brien Highway at East Street/ Cambridge Street | Cambridge Street Eastbound | 0.46 | 14 | B | 0.88 | 31 | D | 0.44 | 13 | B | 0.87 | 30 | D |
| Washington Street at Joy Street | Joy Street Northbound | >1.2 | >120 | F | >1.2 | >120 | F | 0.76 | >120 | F | >1.2 | >120 | F |
| Washington Street at Tufts Street/Knowlton Street | Tufts Street Southbound | >1.2 | >120 | F | >1.2 | >120 | F | >1.2 | >120 | F | >1.2 | >120 | F |
| **Roundabout** | | | | | | | | | | | | | |
| Mystic Valley Pkwy at Alewife Brook Pkwy | -- | >1.2 | 50 | D | 1.00 | 23 | C | 1.18 | 42 | D | 0.99 | 22 | C |

1 Volume-to-capacity ratio
2 Average delay expressed in seconds per vehicle
3 Level-of-Service

### Pedestrians

The Proposed Action would increase pedestrian activity in the vicinity of the stations. In many cases, traffic signal timing and phasing changes at project study area intersections would improve pedestrian LOS slightly. However, pedestrian LOS are not expected to change.

Twenty-nine signalized intersections would need pedestrian improvements (such as increasing Walk/flashing "Don't Walk" times, restriping crosswalks, installing crosswalks, or installing pedestrian signals) to accommodate the expected increase in pedestrian volumes associated with the Proposed Action. These locations are discussed in Section 7.3.3, *Traffic and Transportation Systems,* of this EA.

### Bicycles

The Proposed Action would not physically alter designated bicycle facilities nor disrupt future plans for either on-road or off-road facilities in the project study area. However, the project would attract bicyclists to station locations in both the inbound and outbound direction. The Proposed Action assumes that other on-road bicycle accommodations that are not yet programmed would be available to commuters.

Bicycle parking and storage locations would be maximized using available space to accommodate future projected demand. It is anticipated that during station construction, bicycle parking would be provided for the full Proposed Action demand. The proposed bicycle parking is summarized in Table 6.5-8.

### Parking

The Proposed Action would not physically alter existing public parking supply or a community's ability to expand parking or change enforcement. Many of the parking areas near station locations already see parking violations throughout the day and the available parking supply is limited. Increased enforcement would be necessary to ensure that parking areas would be used appropriately. As discussed in Section 7.3.3, *Traffic and Transportation Systems*, mitigation required to offset traffic impacts would require the removal of up to 12 parking spaces on Boston Avenue.

Approximately 100 spaces for private, employee-only parking would be available at the proposed maintenance and storage facility. The facility is expected to have three working shifts, with all shift changes occurring outside of the commuter peak hours. Therefore, these spaces would not impact local traffic operations or the LOS for any road. There are currently 244 parking spaces at the existing businesses at the proposed maintenance and storage facility site. Locating the facility at the Option L site would result in a reduction of approximately 144 parking spaces, and would not have an adverse impact on local traffic.

### Bus Transportation

Prior to the full construction of the NorthPoint development roadway networks, several roadway improvements are being made along McGrath Highway/Route 28 and within MBTA property to accommodate the buses and parking areas as well as improve pedestrian access. These station/busway-supportive roadway improvements include improvements to Monsignor O'Brien Highway/Route 28 and construction of First Street, as shown in the station plans in Figure 4.4-3.

The bus operations associated with Lechmere Station would be slightly altered once the station is relocated across Monsignor O'Brien Highway. This is expected to have a direct impact on four existing bus routes in the immediate vicinity of the station: MBTA Routes 69, 80, 87, and 88. Three of these routes (Routes 80, 87, and 88) currently enter the station via a right turn off of Monsignor O'Brien Highway and exit the station via a left turn onto Monsignor O'Brien Highway. These buses would continue along their current path down Monsignor O'Brien Highway, but would turn left into and right out of Water Street under the Proposed Action. The Route 69 bus (which connects Lechmere Station with Harvard Square) would continue to travel Cambridge Street to Monsignor O'Brien Highway, entering the station from Water Street via a left turn onto Monsignor O'Brien Highway/Route 28 and a right turn onto Water Street. Until the NorthPoint development is constructed, the Route 69 bus would exit via a left turn onto Water Street and right turn onto Cambridge Street. After construction of NorthPoint the bus would exit via North First Street and left-turns from Water Street would no longer be permitted.

In addition to existing local bus routes, Lechmere Station is planned to accommodate six routes of the planned Urban Ring Circumferential Transit System. Urban Ring service is not assumed to be complete prior to 2030. However, the station is being designed such that Urban Ring service will not be precluded. No other modifications to existing bus routes within the project study area are proposed.

## Proposed Action (2030)

Table 6.5-8 presents the expected peak hour Green Line ridership under the Proposed Action (2030) and how riders are likely to access each station. The remaining riders are assumed to access the station by walking. Proposed Action (2030) traffic volume networks are presented in Appendix D, *Transportation Analysis*.

**Table 6.5-8 Proposed Action Trip Summary by Station (2030)**

| Green Line Station | | Boardings | Park and Ride[1] | Pickup/ Drop-off | Transfer | Walk | Bike[2] |
|---|---|---|---|---|---|---|---|
| Lechmere | Daily | 8,820 | 500 | 430 | 475 | 6,975 | 440 |
| | Peak Hour | 2,920 | 275 | 150 | 475 | 1,875 | 145 |
| Washington Street | Daily | 2,830 | 0 | 155 | 110 | 2,425 | 140 |
| | Peak Hour | 750 | 0 | 55 | 110 | 545 | 40 |
| Gilman Square | Daily | 3,930 | 0 | 215 | 10 | 3,510 | 195 |
| | Peak Hour | 1,530 | 0 | 75 | 10 | 1,370 | 75 |
| Lowell Street | Daily | 1,140 | 0 | 55 | 0 | 1,030 | 55 |
| | Peak Hour | 510 | 0 | 20 | 0 | 465 | 25 |
| Ball Square | Daily | 1,850 | 0 | 115 | 105 | 1,535 | 95 |
| | Peak Hour | 750 | 0 | 40 | 105 | 565 | 40 |
| College Avenue | Daily | 2,140 | 0 | 115 | 390 | 1,530 | 105 |
| | Peak Hour | 720 | 0 | 40 | 390 | 255 | 35 |
| Union Square | Daily | 3,570 | 0 | 215 | 5 | 3,170 | 180 |
| | Peak Hour | 1,330 | 0 | 75 | 5 | 1,185 | 65 |

1 Lechmere parking supply exists currently. No proposed new spaces are associated with the Proposed Action at Lechmere.
2 Based on 2000 Census data and bicycle mode split in each community.

### Traffic Operations

As seen in Table 6.5-9, 14 signalized intersections would continue to operate at unacceptable LOS under the Proposed Action (2030) during at least one peak hour. Five intersections would improve from unacceptable to acceptable traffic operations during at least one peak hour under the Proposed Action (2030):

- Broadway at Medford Street/Dexter Street (evening peak hour only);
- Medford Street at School Street;
- Washington Street at McGrath Highway West;
- Washington Street at Inner Belt Road; and
- Prospect Street at Webster Street/Concord Avenue (morning peak hour only).

An additional four intersections would improve from LOS F to LOS E during at least one peak hour:

- Mystic Valley Parkway at Boston Avenue (morning peak hour only);
- Main Street at High Street/Salem Street/Forest Avenue/Riverside Avenue (morning peak hour only);
- Broadway at Medford Street/Dexter Street (morning peak hour only); and
- Washington Street at McGrath Highway East (evening peak hour only).

Intersections where LOS would degrade by at least one letter are denoted in **bold**. LOS would decrease at two locations:

- Prospect Street at Somerville Avenue (evening peak hour only); and
- Washington Street at Somerville Avenue/Webster Street (evening peak hour only).

For these intersections, vehicular LOS would degrade because signal timings would be adjusted to provide enough time for pedestrians to cross the street before the flashing "Don't Walk" signal ends. Changes in vehicular LOS would be negligible if mitigation measures for pedestrians were not provided. Mitigation measures to offset adverse impacts are described in Section 7.3.3, *Traffic and Transportation Systems*.

## Table 6.5-9 Proposed Action Signalized Intersection Traffic Operations (2030)

| | 2030 No-Build Alternative | | | | | | 2030 Proposed Action | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Morning Peak Hour | | | Evening Peak Hour | | | Morning Peak Hour | | | Evening Peak Hour | | |
| Intersection | V/C[1] | Delay[2] | LOS[3] | V/C | Delay | LOS | V/C | Delay | LOS | V/C | Delay | LOS |
| Mystic Valley Pkwy at Boston Avenue | 1.03 | 81 | F | >1.2 | 111 | F | 1.04 | 67 | E | >1.2 | 101 | F |
| Mystic Valley Pkwy at Auburn Street (East) | 0.88 | 48 | D | 0.84 | 44 | D | 0.90 | 21 | C | 0.90 | 27 | C |
| Mystic Valley Pkwy at Auburn (West) | 0.75 | 12 | B | 0.70 | 35 | C | 0.78 | 8 | A | 0.73 | 19 | B |
| Mystic Valley Pkwy at Winthrop Street | >1.2 | >120 | F | >1.2 | >120 | F | >1.2 | >120 | F | >1.2 | >120 | F |
| Boston Avenue at North Street | 0.56 | 18 | B | 0.43 | 17 | B | 0.60 | 14 | B | 0.46 | 12 | B |
| Boston Avenue at Winthrop Street | 1.10 | 65 | E | 1.09 | 75 | E | 1.06 | 64 | E | 1.10 | 76 | E |
| Boston Avenue at College Avenue | 0.98 | 71 | E | 0.94 | 60 | E | 1.00 | 71 | E | 0.91 | 57 | E |
| Boston Avenue at Harvard Street/Warner Street | 0.78 | 21 | C | 1.03 | 43 | D | 0.79 | 19 | B | 1.01 | 43 | D |
| Broadway at Boston Avenue (Ball Square) | 0.91 | 27 | C | 0.72 | 15 | B | 0.87 | 22 | C | 0.70 | 13 | B |
| College Avenue at Powder House Blvd/Broadway/Warner Street (East Side) | 0.63 | 2 | A | 0.56 | 2 | A | 0.62 | 2 | A | 0.56 | 2 | A |
| College Avenue at Powder House Blvd/Broadway/Warner Street (West Side) | 0.91 | 13 | B | 0.62 | 2 | A | 0.91 | 13 | B | 0.62 | 2 | A |
| Main Street at High Street/Salem Street/Forest Avenue/Riverside Avenue | 1.14 | 104 | F | 0.82 | 37 | D | 1.11 | 80 | E | 0.81 | 31 | C |
| Main Street at Clipper Ship Drive | 0.79 | 1 | A | 0.69 | 5 | A | 0.86 | 2 | A | 0.69 | 5 | A |
| Main Street at Harvard Street | >1.2 | >120 | F | >1.2 | >120 | F | >1.2 | >120 | F | >1.2 | >120 | F |
| Broadway at Medford Street/Dexter Street | 1.14 | 104 | F | 1.01 | 104 | F | 1.05 | 76 | E | 0.94 | 53 | D |
| Medford Street at Central Street | 0.78 | 24 | C | 0.76 | 26 | C | 0.81 | 23 | C | 0.74 | 23 | C |
| Medford Street at School Street | 1.05 | 55 | E | 1.00 | 73 | E | 0.92 | 42 | D | 0.90 | 31 | C |
| Medford Street at Walnut Street | 0.58 | 20 | C | 0.60 | 18 | B | 0.62 | 21 | C | 0.59 | 18 | B |
| Medford Street at Highland Avenue | 0.99 | 66 | E | 0.73 | 20 | C | 0.87 | 60 | E | 0.64 | 15 | B |
| Medford Street at Somerville Avenue/McGrath Hwy | 0.83 | 49 | D | 0.76 | 37 | D | 0.80 | 42 | D | 0.77 | 33 | C |
| Highland Avenue at Lowell Street | 0.67 | 17 | B | 0.53 | 12 | B | 0.67 | 19 | B | 0.54 | 13 | B |
| Highland Avenue at Central Street | 0.65 | 17 | B | 0.74 | 21 | C | 0.63 | 16 | B | 0.75 | 22 | C |
| Highland Avenue at School Street | 0.86 | 33 | C | 0.83 | 29 | C | 0.80 | 30 | C | 0.78 | 25 | C |
| Washington Street at McGrath Hwy (East) | 0.70 | 39 | D | 0.89 | >120 | F | 0.72 | 47 | D | 0.88 | 59 | E |
| Washington Street at McGrath Hwy (West) | 0.84 | >120 | F | 0.68 | >120 | F | 0.83 | 51 | D | 0.67 | 52 | D |
| Washington Street at Inner Belt Road | 1.07 | 61 | E | 0.80 | 17 | B | 0.99 | 39 | D | 0.77 | 16 | B |
| Prospect Street at Somerville Avenue | 1.11 | >120 | F | 1.04 | 75 | E | 1.06 | 110 | F | **1.05** | **91** | **F** |
| Washington Street at Somerville Avenue/Webster Street | 1.06 | 67 | E | 0.91 | 54 | D | 1.08 | 79 | E | **0.87** | **62** | **E** |
| Washington Street at Beacon Street/Kirkland Street | 0.90 | 44 | D | 0.86 | 31 | C | 0.92 | 39 | D | 0.84 | 32 | C |
| Prospect Street at Webster Street/Concord Avenue | 1.08 | 117 | F | >1.2 | >120 | F | 0.85 | 24 | C | 1.18 | 102 | F |
| Prospect Street at Cambridge Street | 0.72 | 26 | C | 0.99 | 49 | D | 0.72 | 27 | C | 0.98 | 41 | D |
| Prospect Street at Hampshire Street | 0.78 | 49 | D | 0.68 | 27 | C | 0.77 | 29 | C | 0.68 | 29 | C |
| Monsignor O'Brien Highway at Land Boulevard/Gilmore Bridge | >1.2 | >120 | F | >1.2 | >120 | F | >1.2 | >120 | F | >1.2 | >120 | F |
| Monsignor O'Brien Highway at Third Street | 1.15 | >120 | F | >1.2 | >120 | F | 1.12 | >120 | F | 1.19 | >120 | F |
| Monsignor O'Brien Highway at Museum Way | 0.87 | 35 | D | 0.8 | 28 | C | 0.85 | 35 | C | 0.80 | 27 | C |
| Cambridge Street at First Street | 0.57 | 23 | C | 0.66 | 49 | D | 0.57 | 23 | C | 0.66 | 53 | D |
| Monsignor O'Brien Highway at North First Street | 0.86 | 32 | C | 0.85 | 52 | D | 0.85 | 31 | C | 0.84 | 49 | D |
| Monsignor O'Brien Highway at Water Street | 0.72 | 14 | B | 0.60 | 16 | B | 0.69 | 13 | B | 0.58 | 15 | B |

Note: Intersections degrading by at least one LOS are denoted in **bold**.
1 Volume-to-capacity ratio
2 Average delay expressed in seconds per vehicle
3 Level-of-Service

As shown in Table 6.5-10, two unsignalized intersections are expected to see an increase in delay under the Proposed Action (2030). One unsignalized intersection is expected to see a decrease in delay under the Proposed Action (2030), but no change in LOS. The remaining intersections would continue to operate as in the No-Build Alternative. Traffic operations at the unsignalized intersection of Medford Street and Pearl Street are not expected to degrade under the Proposed Action. However, given this location's proximity to the proposed Gilman Square Station, there would be a need to accommodate pedestrians to and from the station across Medford Street. Mitigation measures needed to achieve this accommodation are described in Section 7.3.3, Traffic and Transportation Systems.

**Table 6.5-10 Proposed Action Unsignalized Intersection Traffic Operations (2030)**

| | | 2030 No-Build Alternative | | | | | | 2030 Proposed Action | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Morning Peak Hour | | | Evening Peak Hour | | | Morning Peak Hour | | | Evening Peak Hour | | |
| Intersection | Critical Movement | V/C[1] | Delay[2] | LOS[3] | V/C | Delay | LOS | V/C | Delay | LOS | V/C | Delay | LOS |
| Boston Avenue at High Street/ Sagamore Avenue | High Street Northbound | >1.2 | >60 | F | >1.2 | >60 | F | >1.2 | >60 | F | >1.2 | >60 | F |
| College Avenue at George Street | George Street Westbound | 0.90 | 38 | E | 0.92 | 41 | E | 0.91 | 38 | E | 0.93 | 45 | E |
| Main Street at George Street | George Street Eastbound | >1.2 | >60 | F | >1.2 | >60 | F | >1.2 | >60 | F | >1.2 | >60 | F |
| Main Street at Mystic Avenue/ Fire Station | Main Street Eastbound | >1.2 | >60 | F | >1.2 | >60 | F | >1.2 | >60 | F | >1.2 | >60 | F |
| Main Street at South Street/ Mystic Valley Pkwy Eastbound Ramps | South Street Eastbound | >1.2 | >60 | F | >1.2 | >60 | F | >1.2 | >60 | F | >1.2 | >60 | F |
| Main Street at Mystic Valley Pkwy Westbound Ramps | Mystic Valley Pkwy Westbound Ramps | >1.2 | >60 | F | >1.2 | >60 | F | >1.2 | >60 | F | >1.2 | >60 | F |
| Medford Street at Lowell Street | Lowell Street Northbound | >1.2 | >60 | F | 0.41 | 22 | C | >1.2 | >60 | F | 0.40 | 22 | C |
| Medford Street at Pearl Street | Pearl Street Westbound | >1.2 | >60 | F | >1.2 | >60 | F | >1.2 | >60 | F | >1.2 | >60 | F |
| Broadway at Winchester Street/Albion Street | Winchester/Albion Southbound | >1.2 | >60 | F | 1.03 | >60 | F | >1.2 | >60 | F | 0.97 | >60 | F |
| Monsignor O'Brien Highway at Gore Street | Gore Street Northbound | 0.42 | 10 | A | 0.13 | 10 | B | 0.04 | 10 | A | 0.13 | 10 | B |
| Monsignor O'Brien Highway at East Street/Cambridge Street | Cambridge Street Eastbound | 0.46 | 14 | B | 0.88 | 31 | D | 0.44 | 13 | B | 0.87 | 30 | D |
| Washington Street at Joy Street | Joy Street Northbound | >1.2 | >120 | F | >1.2 | >120 | F | 0.83 | >120 | F | >1.2 | >120 | F |
| Washington Street at Tufts Street/ Knowlton Street | Tufts Street Southbound | >1.2 | >120 | F | >1.2 | >120 | F | >1.2 | >120 | F | >1.2 | >120 | F |
| **Roundabout** | | | | | | | | | | | | | |
| Mystic Valley Pkwy at Alewife Brook Pkwy | -- | >1.2 | 55 | D | 0.98 | 22 | C | >1.2 | 56 | E | 1.01 | 24 | C |

Note: Although the results present LOS D during the morning peak hour at Mystic Valley Parkway and Alewife Brook Parkway it should be noted that 55.1 seconds is the threshold for LOS E conditions. This location is considered to operate at capacity under both No-Build Alternative and Proposed Action. The impact of the Proposed Action on this location is negligible.

1 Volume-to-capacity ratio

2 Average delay expressed in seconds per vehicle

3 Level-of-Service

## Pedestrians

The Proposed Action would increase pedestrian activity in the vicinity of the stations. In many cases, traffic signal timing and phasing changes at project study area intersections would improve pedestrian delays slightly. However, the designated LOS are not expected to change.

Twenty-nine signalized intersections would need pedestrian improvements (such as increasing Walk/flashing "Don't Walk" times, restriping crosswalks, installing crosswalks, or installing pedestrian signals) to accommodate the expected increase in pedestrian volumes associated with the Proposed Action. These locations are discussed in Section 7.3.3, *Traffic and Transportation Systems*. Pedestrian volumes for the Proposed Action are provided in Appendix D, *Transportation Analysis*.

## Bicycles

The Proposed Action would not physically alter designated bicycle facilities nor disrupt future plans for either on-road or off-road facilities in the project study area. However, the Project would attract bicyclists to stations. The Proposed Action assumes that the proposed Somerville Community Path extension is completed with connections to Green Line Extension stations. It is also assumed that other on-road bicycle accommodations that are not yet programmed would be available to commuters.

To accommodate demand, bicycle parking and storage locations would be maximized using available space. Based on the bicycle demand estimates provided in Table 6.5-8, at a minimum the following bicycle parking would be provided at each Station[8] (numbers are rounded to the nearest 10[9]):

- Lechmere Station – 250 spaces
- Washington Street Station – 70 spaces
- Gilman Square Station – 140 spaces
- Lowell Street Station – 50 spaces
- Ball Square Station – 70 spaces
- College Avenue Station – 70 spaces
- Union Square Station – 120 spaces

Additional public bicycle parking at Lechmere Station is planned as part of the NorthPoint project.

8 *Bicycle Parking Guidelines (2nd Edition)*: A Set of Recommendations from the Association of Pedestrian and Bicycle Professionals (APBP), Cedarburg, WI, 2010.

9 The number of bicycle parking spaces (long term plus short term) represents approximately nine percent of the projected total morning peak period boardings (all modes).

The communities of Cambridge, Somerville, and Medford have bicycle guidance that is continually evolving. As such, bicycle parking standards and rack types should be coordinated with officials during design. Based on current standards, when installing bicycle parking the following should be considered:

- All ADA dimensions will take precedence over any other requirement or guidance.
- The part of the rack that supports the bicycle should be well anchored to the ground.
- The rack should support the bicycle upright on its frame.
- The rack should prevent the bike wheel from tipping over.
- The rack should provide a two-point support system for the bicycle and allow the user to securely lock the frame and wheels.
- The rack should resist being cut or damaged by common hand tools such as bolt or pipe cutters.
- Front-in parking should allow a U-lock to lock the front wheel and the bicycle frame.
- Back-in parking should allow a U-lock to lock the rear wheel and seat tube of the bicycle.
- For parallel storage, rack elements should be arranged 30 inches on center to allow space for two bicycles to be secured to each rack element.
- Where two or more racks are provided at the same location, six feet should be allowed for each row of bicycles, with four-foot aisle width between rows.
- The placement of the racks should not interfere with the sight lines of pedestrians and motorists.
- Racks should be separate from the following physical features by at least the prescribed minimum distance:
    - Corners – 20 feet
    - Pedestrian ramps and fire hydrants – 10 feet
    - Building or curb (parallel) – one foot
    - Minimum sidewalk clearance – four feet

## Parking

The Proposed Action would not physically alter existing public parking supply or a community's ability to expand parking or change enforcement. The available parking supply is limited and many of the parking areas near station locations already see parking violations throughout the day. Increased enforcement would be necessary to ensure that parking areas would be used appropriately. As discussed in Section 7.3.3, *Traffic and Transportation Systems*, mitigation required to offset traffic impacts would require the removal of up to 12 parking spaces on Boston Avenue.

Approximately 100 spaces for private, employee-only parking would be available at the maintenance and storage facility. The facility is expected to have three working shifts, with all shift changes occurring outside of the commuter peak hours. These spaces would not impact local traffic operations or the LOS for any road. As discussed in the Proposed Action in 2015, siting the facility at the Option L site would result in a reduction of approximately 144 parking spaces and would not have an adverse impact on local traffic.

#### Bus Transportation

Bus transportation would be the same in 2030 as 2015 for the No-Build Alternative and Proposed Action, as described previously.

### 6.5.3 Safety

As discussed in Section 5.6, *Traffic*, the available safety data do not show a definitive pattern of safety deficiencies but do show a number of concerns throughout the project study area. Traffic volume added to these intersections as a direct result of the Proposed Action in both 2015 and 2030 would be minimal.

Traffic signal timing and phasing adjustments proposed as part of the Proposed Action in both 2015 and 2030 could help to reduce incidents within the project study area by ensuring the provision of adequate clearance intervals and pedestrian timings. Designated pickup/drop-off areas would be designed to ensure proper spacing between signalized intersections and provide adequate sight distance.

### 6.5.4 Construction Impacts

Construction impacts for the Proposed Action include traffic disruptions related to construction equipment, bridge closures, and traffic detours. These impacts are expected to be temporary and to terminate when construction is complete. Mobilizing construction equipment is not expected to impact traffic operations at project study area intersections. Road closures related to bridge reconstruction would require traffic detours and could disrupt typical travel patterns in the project study area. Parking spaces could be temporarily displaced, particularly in the immediate vicinity of station and bridge construction.

Seven roadway bridges would be reconstructed under the Proposed Action. Bridge reconstruction would be staged whenever possible to maintain traffic over respective bridges during construction. Construction staging would be required for roadways, intersections, and rail traffic. In some cases, staged construction is not feasible and the bridge would have to be closed during reconstruction. The project would limit bridge closures such that no two consecutive bridges would be closed at the same time. Detour plans would be required to provide alternate traffic routes. Traffic detour plans would be closely coordinated and approved by MassDOT, the City of Cambridge, City of Somerville, and City of Medford, as well as the respective Fire and Police Departments. A robust public outreach program would be developed, notifying the public of construction activities through telephone calls, email blasts, website notices, and flyer distributions. Public information meetings would be conducted, identifying bridge construction and roadway closure locations, intersection construction activities, construction schedules, and temporary traffic, safety, and pedestrian detours through construction areas. The preliminary analysis of construction staging and sequencing shows that it is feasible to construct the project while maintaining railroad operations as well as traffic and pedestrian path access. Project bridge designs and construction staging plans would be refined during preliminary engineering in coordination with the communities. Bridge construction is discussed in further detail in Section 4.4.10, *Construction Staging and Sequencing*, of this EA.

## 6.5.5 Summary

The Proposed Action would impact traffic and the transportation system. The proposed mitigation measures are described in full in Section 7.3.3, *Traffic and Transportation Systems*. Key points include:

### Traffic Operations

- With mitigation, the Proposed Action would not have an adverse impact on traffic operations throughout the project study area.

### Pedestrians

- Pedestrian improvements at 29 signalized intersections would be implemented throughout the project study area to accommodate the expected number of pedestrians accessing proposed stations.
- Pedestrian delays throughout the project study area would be improved and signals would be timed to ensure pedestrians have adequate time to cross the street.

### Bicycles

- The Proposed Action would not physically alter designated bicycle facilities nor disrupt plans for future on-road or off-road facilities.
- When the opportunity is available, connections would be made from bicycle facilities to the proposed stations.
- Bicycle parking would be provided at station locations to accommodate and encourage commuting to the stations by bicycle.

### Parking

- Minimal impacts to parking are expected (fewer than 12 places displaced on Boston Avenue near Winthrop Street).
- Enforcement would be necessary to ensure that on-street parking is being used appropriately.

### Bus Transportation

- Slight operational changes to bus service would be required at the relocated Lechmere Station as a result of the station relocation.
- No other bus routes or services would be modified.

### Construction Impacts

- Construction impacts could result in temporary lane closures and temporary traffic detours.
- In the vicinity of the stations, construction could temporarily displace on-street parking.
- Construction staging would limit the number of temporary bridge closures and ensure that adjacent bridges are not closed at the same time.

# 6.6 Air Quality

This section includes a mesoscale and microscale air quality analysis for the following pollutants: VOCs, $NO_X$, $CO_2$, CO, and PM. In addition, an evaluation of air toxics was conducted. The full results of the air quality analysis are provided in Appendix E, *Air Quality Analysis*.

## 6.6.1 Pollutants of Concern

Air pollution is of concern because of its demonstrated adverse effects on human health. Of special concern are the respiratory effects of the pollutants and their potential toxic effects. The transportation air pollutants of concern include:

- **Carbon monoxide (CO).** CO is a colorless and odorless gas that is a product of incomplete combustion. Carbon monoxide is absorbed by the lungs and reacts with hemoglobin to reduce the oxygen carrying capacity of the blood. At low concentrations, CO has been shown to aggravate the symptoms of cardiovascular disease. It can cause headaches and nausea and, at sustained high concentration levels, can lead to coma and death.

- **Particulate Matter (PM).** PM is made up of small solid particles and liquid droplets. $PM_{10}$ refers to particulate matter with a nominal aerodynamic diameter of 10 micrometers or less, and $PM_{2.5}$ refers to particulate matter with an aerodynamic diameter of 2.5 micrometers or less. Particulates can enter the body through the respiratory system. Particulates over 10 micrometers in size are generally captured in the nose and throat and are readily expelled from the body. Particles smaller than 10 micrometers, and especially particles smaller than 2.5 micrometers, can reach the air ducts (bronchi) and the air sacs (alveoli) in the lungs. Particulates are associated with increased incidence of respiratory diseases, cardiopulmonary disease, and cancer.
- **Ozone.** Ozone is a strong oxidizer and an irritant that affects the lung tissues and respiratory functions. Exposure to ozone can impair the ability to perform physical exercise, can result in symptoms such as tightness in the chest, coughing, and wheezing, and can ultimately result in asthma, bronchitis, and emphysema.
- **Volatile organic compounds (VOCs).** VOCs are a general class of compounds containing hydrogen and carbon and are a precursor to the formation of the pollutant ozone. While concentrations of VOCs in the atmosphere are not generally measured, ground-level ozone is measured and used to assess potential health effects. Emissions of VOCs and $NO_X$ react in the presence of heat and sunlight to form ozone in the atmosphere. Accordingly, ozone is regulated as a regional pollutant and is not assessed on a project-specific basis.
- **Nitrogen Oxides (NO).** When combustion temperatures are extremely high, as in automobile engines, atmospheric nitrogen gas can combine with oxygen gas to form various oxides of nitrogen. Of these, nitric oxide (NO) and nitrogen dioxide ($NO_2$) are the most noteworthy air pollutants. This group of pollutants is generally referred to as $NO_X$. Nitric oxide is relatively harmless to humans but quickly converts to $NO_2$. Nitrogen dioxide has been found to be a lung irritant and can lead to respiratory illnesses. Nitrogen oxides, along with VOCs, are also precursors to ozone formation.
- **Carbon Dioxide ($CO_2$).** GHGs are essential to maintaining the temperature of the Earth; without them the planet would be so cold as to be uninhabitable. While there are other GHGs, $CO_2$ is the predominant contributor to global warming, and emissions can be calculated for $CO_2$ with readily accessible data.

### 6.6.2 Air Quality Methodology

The EPA and MassDEP have established guidelines that define the modeling and review criteria for local and regional air quality analyses prepared pursuant to the MEPA process. These guidelines require that the project determine the change in project-related vehicle emissions. If the VOCs and other emissions from the Proposed Action are greater than the No-Build Alternative, then the project should include all reasonable and feasible emission reduction mitigation measures. Massachusetts has incorporated this criterion into the SIP.

The EPA and MassDEP guidelines require that the air quality study utilize traffic and emissions data for existing and future (No-Build Alternative and Proposed Action) conditions. The traffic and emissions data are incorporated into the EPA air quality models and modeling procedures to generate emissions estimates that demonstrate whether or not the project would have air quality impacts.

The air quality study for the Green Line Extension project evaluated several conditions, including the 2007 existing conditions (see Section 5.7, *Air Quality*, of this EA), the No-Build Alternative and Proposed Action in 2015 and 2030.

The air quality study of the No-Build Alternative (2015 and 2030) included regional background traffic growth and planned roadway improvements that are expected by that specific analysis year. The Proposed Action analysis includes the anticipated future changes in travel demand. The year 2015 was selected for the interim analysis year. The year 2030 was selected as the future year of analysis to be consistent with the statewide model as well as to be consistent with the regional long-range transportation plan. Future project-related emission calculations are based upon changes in traffic and emission factor data. The traffic data include traffic volumes, VMT, roadway operations, and physical roadway improvements. The emission factor data included emission reduction programs, years of analysis, and roadway speeds.

The microscale and mesoscale analyses developed traffic (volumes and speeds) and emission factor data for the No-Build Alternative and Proposed Action in 2015 and 2030. These data were incorporated into air quality models to demonstrate that the proposed Green Line Extension project would meet the CAAA and SIP criteria. The mesoscale analysis evaluated the regional air quality impacts from the project by determining the change in total ozone precursor emissions (VOCs and $NO_x$) for the existing and future conditions within the project study area. The microscale analysis calculated the CO and PM concentrations for the same conditions at congested intersections near the project study corridor.

Further information about the air quality modeling methodology can be found in Section 5.7, *Air Quality*, of this EA.

### 6.6.3 Modeling Assumptions

Transportation Conformity and SIP air quality analyses utilize traffic data from the statewide traffic model and the EPA's mobile source emissions factor model, MOBILE6.2. The statewide traffic model is maintained by the CTPS, the technical staff of the Boston Region MPO, which is responsible for SIP air quality submissions.

The statewide traffic model is the basis for determining existing and future traffic data for CAAA and NEPA submissions. The EPA requires that statewide traffic models used for SIP submissions be based upon the most recent approved planning-level data. As a result, statewide traffic models are periodically updated to include newly identified background projects, land use changes, and model enhancements. Statewide traffic models typically include the roadway network that exists at the time it is run and regionally important projects (background projects) that are reasonably expected to be constructed by the design year (*i.e.*, 20 years into the future). Similarly, the MPOs establish and periodically update the land use for existing and future years.

The statewide traffic model that the CTPS uses for forecasting travel demand is based on procedures and data that have evolved over many years. It uses the most up-to-date information, transportation networks, and input data available to the CTPS at the time of analysis. The statewide traffic model simulates existing travel modes for transit, automobiles, and walking/bicycling, and forecasts future year travel on the entire transportation system, spanning, in this instance, the majority of eastern Massachusetts. It uses population, employment, number of households, automobile ownership, highway and transit LOS, as well as downtown parking costs, automobile operating costs and transit fares as important inputs in applying the model to the real world condition. As required by EPA, these inputs are constantly updated so that the model set simulates current travel patterns with as much accuracy as possible.

The greatest challenge to the air quality modeling is ensuring consistent results when the statewide traffic and the mobile source emission factor models are updated. For example, the statewide traffic model of 2006 was used to establish the 2008 Federal Register Replacement/Substitution project package emissions criteria.[10] This air quality modeling used the most informative transportation network and input data available at that time. The air quality modeling for the Green Line Extension project initially used an improved statewide traffic model with an updated roadway network, more current land use data, and a newer version of EPA's MOBILE6.2. The analysis presented in this EA used a further updated improved statewide traffic model with an updated roadway network and more current land use data. All of these measures result in improved accuracy of the present day and future air quality estimates. These modeling assumptions and this real-time approach to air quality modeling results in emission values that are considered appropriate for the SIP process. In fact, this air quality modeling approach is required by EPA for evaluating Transportation Plans, Transportation Improvement Programs, and projects for SIPs and NEPA documents.

The microscale analysis calculated CO concentrations for the No-Build Alternative and Proposed Action in 2015 and 2030. The concentrations are expressed in parts per

10 Federal Register (59 FR 50495-50498). October 4, 1994, *SIP Approved Projects Plus Ten Percent Package*.

million (ppm) and include a 1-hour background concentration of 3.0 ppm which was based on background values determined by the MassDEP from air quality monitoring documented in the *New England Annual Air Quality Report*.[11] The NAAQS for CO sets maximum concentrations of 35 ppm for a 1-hour period and nine ppm for an 8-hour period, each not to be exceeded more than once per year.

The 1-hour CO concentrations were calculated using EPA's CAL3QHC model, with evening peak hour traffic and emission data. The 8-hour CO concentrations were derived by applying a persistence factor of 0.68 to the 1-hour CO concentrations. This persistence factor was obtained from the MassDEP's nearest CO monitoring station at 590 Commonwealth Avenue, Kenmore Square, Boston. It represents the average ratio of second highest 8-hour to second highest 1-hour CO reading.

The microscale analysis calculated the 24-hour and annual $PM_{2.5}$ concentrations for the No-Build Alternative and the Proposed Action in 2015 and 2030. The predicted 1-hour $PM_{2.5}$ concentrations were calculated using EPA's CAL3QHC model and were then adjusted using MassDEP standards to develop the 24-hour and annual $PM_{2.5}$ concentrations. The concentrations are expressed in micrograms per cubic meter ($\mu g/m^3$) and include a 24-hour background concentration of 29.7 $\mu g/m^3$ and an annual background concentration of 11.7 $\mu g/m^3$, which was based on MassDEP air quality monitoring data.

The microscale analysis calculated the 24-hour $PM_{10}$ concentrations for the No-Build Alternative and the Proposed Action in 2015 and 2030. The concentrations are expressed in $\mu g/m^3$ and include a 24-hour background concentration of 45.7 $\mu g/m^3$, which was based on MassDEP air quality monitoring data.

The air quality study included a mesoscale analysis that estimates the area-wide emissions of VOCs, $NO_X$, $CO_2$, CO, and PM emissions. The mesoscale analysis evaluated the changes in emissions based upon changes in the average daily traffic volumes, roadway lengths, and vehicle emission rates. To demonstrate compliance with the SIP criteria, the air quality study must show the proposed Green Line Extension project's change in daily (24-hour period) VOC and $NO_X$ emissions. Using EPA-recommended air quality modeling techniques, total pollutant emissions were calculated for the No-Build Alternative and the Proposed Action in 2015 and 2030.

11 United States Environmental Protection Agency, Region I. *2006 New England Annual Report on Air Quality*, July 2007. Available at: http://www.epa.gov/region01/oeme/AnnualReport2006.pdf

**Table 6.6-1 National Ambient Air Quality Standards**

| | Primary Standards | | Secondary Standards | |
|---|---|---|---|---|
| **Pollutant** | **Level** | **Averaging Time** | **Level** | **Averaging** |
| Carbon Monoxide | 9 ppm (10 mg/$m^3$)<br>35 ppm (40 mg/$m^3$) | 8-hour [1]<br>1-hour [1] | None<br>None | |
| Lead | 1.5 µg/$m^3$ [2] | Quarterly Average | Same as Primary | |
| Nitrogen Dioxide | 53 ppb [3]<br>100 ppb | Annual (Arithmetic Average)<br>1-hour[4] | Same as Primary<br>None | |
| Particulate Matter ($PM_{10}$) | 150 µg/$m^3$ | 24-hour [5] | Same as Primary | |
| Particulate Matter ($PM_{2.5}$) | 15 µg/$m^3$<br>35 µg/$m^3$ | Annual (Arithmetic Mean) [6]<br>24-hour [7] | Same as Primary<br>Same as Primary | |
| Ozone | 0.075 ppm (2008 std)<br>0.08 ppm (1997 std)<br>0.12 ppm | 8-hour [8]<br>8-hour [9]<br>1-hour (applied to limited areas) [10] | Same as Primary<br>Same as Primary | |
| Sulfur Dioxide | 0.03 ppm<br>0.14 ppm<br>75 ppb[11] | Annual<br>24-hour [1]<br>1-hour | 0.5 ppm<br>0.5 ppm<br>None | 3-hour [1]<br>3-hour |

1 Not to be exceeded more than once per year.
2 Final rule signed October 15, 2008.
3 The official level of the annual $NO_2$ standard is 0.053 ppm, equal to 53 ppb, which is shown here for the purpose of clearer comparison to the 1-hour standard.
4 To attain this standard, the 3-year average of the 98th percentile of the daily maximum 1-hour average at each monitor within an area must not exceed 100 ppb (effective January 22, 2010).
5 Not to be exceeded more than once per year on average over 3 years.
6 To attain this standard, the 3-year average of the weighted annual mean $PM_{2.5}$ concentrations from single or multiple community-oriented monitors must not exceed 15.0 µg/$m^3$.
7 To attain this standard, the 3-year average of the 98th percentile of 24-hour concentrations at each population-oriented monitor within an area must not exceed 35 µg/$m^3$ (effective December 17, 2006).
8 To attain this standard, the 3-year average of the fourth-highest daily maximum 8-hour average ozone concentrations measured at each monitor within an area over each year must not exceed 0.075 ppm (effective May 27, 2008).
9 (a) To attain this standard, the 3-year average of the fourth-highest daily maximum 8-hour average ozone concentrations measured at each monitor within an area over each year must not exceed 0.08 ppm.
(b) The 1997 standard—and the implementation rules for that standard—would remain in place for implementation purposes as EPA undertakes rulemaking to address the transition from the 1997 ozone standard to the 2008 ozone standard.
(c) EPA is in the process of reconsidering these standards (set in March 2008).
10 (a) EPA revoked the 1-hour ozone standard in all areas, although some areas have continuing obligations under that standard ("anti-backsliding").
(b) The standard is attained when the expected number of days per calendar year with maximum hourly average concentrations above 0.12 ppm is < 1.
11 (a) Final rule signed June 2, 2010. To attain this standard, the 3-year average of the 99th percentile of the daily maximum 1-hour average at each monitor within an area must not exceed 75 ppb.

## 6.6.4 Air Quality Standards

The EPA has set the NAAQS (Table 6.6-1) to protect the public health. The predominant source of pollution anticipated from the Proposed Action is emissions from project-related motor vehicle traffic. CO is directly emitted by motor vehicles. CO concentrations can be estimated by computer modeling, which can then be compared to the NAAQS.

## 6.6.5 Microscale Analysis

Future estimates of project-related emissions of CO and PM are based upon changes in traffic and emission factor data. The traffic data include traffic volumes, VMT, signal cycle timing, and physical roadway improvements. The emission factor data include years of analysis and roadway speeds. The microscale analysis for the Proposed Action is based upon changes in these parameters.

### Microscale CO Emissions Results

The microscale analysis results for all the intersections are presented in Tables 6.6-2 and 6.6-3 for predicted 1-hour and 8-hour CO concentrations, respectively. All of the predicted 1-hour and 8-hour concentrations are below the CO NAAQS of 35 and nine ppm, respectively. These values are consistent with the area's designation as a Maintenance CO attainment area.

The microscale analysis indicates that reductions in CO concentrations are expected to occur over time when compared to the 2007 existing condition. The calculated future CO concentrations (both 1- and 8-hour) in 2015 and 2030 are generally equal to or less than the 2007 existing conditions concentrations.

The No-Build Alternative (2015) has predicted 1-hour CO emissions ranging from a minimum of 4.0 ppm to a maximum of 6.3 ppm. Similarly, the No-Build Alternative (2015) has predicted 8-hour CO emissions range from a minimum of 2.7 ppm to a maximum of 4.3 ppm. The highest 1-hour and 8-hour Proposed Action (2015) CO are predicted at the intersection of Monsignor O'Brien Highway at Charlestown Avenue and Land Boulevard (6.3 ppm and 4.3 ppm, respectively). The lowest Proposed Action (2015) CO emissions of 3.9 ppm for the 1-hour CO and 2.7 ppm for the 8-Hour CO would be experienced at the intersection of Mystic Valley Parkway Eastbound off-ramp at Main Street and South Street.

The No-Build Alternative (2030) predicted 1-hour CO emissions range from a minimum of 4.0 ppm to a maximum of 7.8 ppm. Similarly, the No-Build Alternative (2030) predicted 8-hour CO emissions range from a minimum of 2.7 ppm to a maximum of 5.3 ppm. The highest 1-hour and 8-hour 2030 Build Alternative CO emissions are predicted at the intersection of Monsignor O'Brien Highway at Charlestown Avenue and Land Boulevard (6.6 ppm and 4.5 ppm, respectively). The lowest 1-hour and 8-hour CO emissions under Proposed Action (2030) conditions of 4.0 ppm and 2.7 ppm, respectively would be experienced at the intersection of Highland Street at Central Street and School Street at Medford Street.

## Table 6.6-2 Predicted Maximum 1-Hour CO Concentrations (Parts Per Million) [1, 2]

| Intersection Number and Intersection [3] | | 2007 Existing Condition | 2015 No-Build Alternative | 2015 Proposed Action | 2030 No-Build Alternative | 2030 Proposed Action |
|---|---|---|---|---|---|---|
| 1 | Mystic Valley Parkway at Boston Avenue | 5.5 | 4.8 | 4.7 | 4.6 | 4.5 |
| 2 | Mystic Valley Parkway at Winthrop Street | 6.6 | 5.6 | 4.8 | 5.3 | 5.1 |
| 3 | Mystic Valley Parkway Eastbound off-ramp at Main Street and South Street | 4.9 | 4.7 | 3.9 | 4.3 | 4.3 |
| 4 | Boston Avenue at College Avenue | 5.3 | 4.5 | 4.4 | 4.5 | 4.2 |
| 5 | Harvard Street at Main Street | 4.8 | 4.5 | 4.3 | 4.4 | 4.3 |
| 6 | Medford Street at Broadway and Dexter Street | 5.6 | 4.6 | 4.3 | 4.7 | 4.3 |
| 7 | Highland Street at Central Street | 4.5 | 4.0 | 4.0 | 4.0 | 4.0 |
| 8 | School Street at Medford Street | 4.6 | 4.1 | 4.0 | 4.0 | 4.0 |
| 9 | Somerville Avenue at Washington and Prospect Street | 6.4 | 5.5 | 5.5 | 5.2 | 5.1 |
| 10 | Washington Street at McGrath Highway | 5.8 | 5.1 | 4.8 | 4.8 | 4.9 |
| 11 | Monsignor O'Brien Highway at Third Street | 6.0 | 5.6 | 5.5 | 5.4 | 5.3 |
| 12 | Monsignor O'Brien Highway at East Street/ Cambridge Street | 5.7 | 5.0 | 5.0 | 5.3 | 4.6 |
| 13 | Cambridge Street at First Street | 4.8 | 4.8 | 4.8 | 4.8 | 4.7 |
| 14 | Monsignor O'Brien Highway at Charlestown Avenue/Land Boulevard | 8.3 | 6.3 | 6.3 | 7.8 | 6.6 |

Source: Vanasse Hangen Brustlin, Inc. 2010.

1 The remaining intersections are included in Appendix E, *Air Quality Analysis*. The concentrations are expressed in ppm and include a 1-hour background concentration of 3.0 ppm. The 1-hour NAAQS for CO is 35 ppm. The emissions presented represent the highest emissions experienced at each intersection for each alternative. The air quality study assumes that if these intersections meet the NAAQS, then all other intersections would have lower volumes and better LOS, can be assumed to also meet the NAAQS.

2 The Proposed Action used for the air quality analysis include the physical and operational mitigation proposed to improve traffic operations (as outlined in Section 6.5, *Traffic and Transportation Systems*) which is based on the updated CTPS statewide traffic model, August 2010. In addition, the *MOBILE* emission factors were updated to the latest available information in October 2010.

3 Figure 5.7-1 shows the intersections evaluated.

## Table 6.6-3 Predicted Maximum 8-Hour CO Concentrations (Parts Per Million) [1, 2]

| Intersection Number and Intersection [3] | 2007 Existing Condition | 2015 No-Build Alternative | 2015 Proposed Action | 2030 No-Build Alternative | 2030 Proposed Action |
|---|---|---|---|---|---|
| 1 Mystic Valley Parkway at Boston Avenue | 3.7 | 3.3 | 3.2 | 3.1 | 3.1 |
| 2 Mystic Valley Parkway at Winthrop Street | 4.5 | 3.8 | 3.5 | 3.6 | 3.6 |
| 3 Mystic Valley Parkway Eastbound off-ramp at Main Street and South Street | 3.3 | 3.1 | 2.7 | 2.9 | 2.9 |
| 4 Boston Avenue at College Avenue | 3.6 | 3.1 | 3.0 | 3.1 | 2.9 |
| 5 Harvard Street at Main Street | 3.3 | 3.1 | 3.1 | 3.0 | 3.0 |
| 6 Medford Street at Broadway and Dexter Street | 3.8 | 3.1 | 2.9 | 3.2 | 2.9 |
| 7 Highland Street at Central Street | 3.0 | 2.7 | 2.7 | 2.7 | 2.7 |
| 8 School Street at Medford Street | 3.1 | 2.8 | 2.7 | 2.7 | 2.7 |
| 9 Somerville Avenue at Washington and Prospect Street | 4.4 | 3.7 | 3.7 | 3.5 | 3.5 |
| 10 Washington Street at McGrath Highway | 3.9 | 3.5 | 3.3 | 3.3 | 3.3 |
| 11 Monsignor O'Brien Highway at Third Street | 4.1 | 3.8 | 3.7 | 3.7 | 3.6 |
| 12 Monsignor O'Brien Highway at East Street/ Cambridge Street | 3.9 | 3.4 | 3.4 | 3.6 | 3.1 |
| 13 Cambridge Street at First Street | 3.2 | 3.3 | 3.3 | 3.3 | 3.2 |
| 14 Monsignor O'Brien Highway at Charlestown Avenue/Land Boulevard | 5.6 | 4.3 | 4.3 | 5.3 | 4.5 |

Source: Vanasse Hangen Brustlin, Inc. 2010.

1 The remaining intersections are included in Appendix E, *Air Quality Analysis*. The concentrations are expressed in ppm and a persistence factor of 0.68 was used. The 8-hour NAAQS for CO is 9 ppm. The emissions presented represent the highest emissions experienced at each intersection for each alternative. The air quality study assumes that if this intersection meets the NAAQS, then all other intersections would have lower volumes and better LOS, can be assumed to also meet the NAAQS.

2 The Proposed Action used for the air quality analysis include the physical and operational mitigation proposed to improve traffic operations (as outlined in Section 6.5, *Traffic and Transportation Systems*) which is based on the updated CTPS statewide traffic model, August 2010. In addition, the *MOBILE* emission factors were updated to the latest available information in October 2010.

3 Figure 5.7-1 shows the intersections evaluated.

## Microscale $PM_{10}$ Emissions Results

Table 6.6-4 presents the predicted 24-hour $PM_{10}$ concentrations for the project. The 2015 24-hour $PM_{10}$ concentrations for the Proposed Action ranged from a minimum of 47 $\mu g/m^3$ to a maximum of 50 $\mu g/m^3$ at the study intersections. The 2030 24-hour $PM_{10}$ concentrations for the Proposed Action ranged from a minimum of 47 $\mu g/m^3$ to a maximum of 49 $\mu g/m^3$. All of the 24-hour $PM_{10}$ concentrations are well below the PM NAAQS of 150 $\mu g/m^3$.

**Table 6.6-4 Predicted Maximum 24-Hour $PM_{10}$ Concentrations ($\mu g/m^3$) [1, 2]**

| Intersection Number and Intersection [3] | | 2007 | 2015 | | 2030 | |
|---|---|---|---|---|---|---|
| | | Existing Condition | No-Build Alternative | Proposed Action | No-Build Alternative | Proposed Action |
| 1 | Mystic Valley Parkway at Boston Avenue | 49 | 48 | 48 | 48 | 48 |
| 2 | Mystic Valley Parkway at Winthrop Street | 51 | 49 | 49 | 49 | 49 |
| 3 | Mystic Valley Parkway Eastbound off-ramp at Main Street and South Street | 49 | 48 | 48 | 48 | 48 |
| 4 | Boston Avenue at College Avenue | 48 | 47 | 47 | 47 | 47 |
| 5 | Harvard Street at Main Street | 49 | 48 | 48 | 47 | 48 |
| 6 | Medford Street at Broadway and Dexter Street | 49 | 47 | 47 | 47 | 47 |
| 7 | Highland Street at Central Street | 48 | 47 | 47 | 47 | 47 |
| 8 | School Street at Medford Street | 48 | 47 | 47 | 47 | 47 |
| 9 | Somerville Avenue at Washington and Prospect Street | 50 | 49 | 49 | 48 | 48 |
| 10 | Washington Street at McGrath Highway | 49 | 48 | 48 | 48 | 48 |
| 11 | Monsignor O'Brien Highway at Third Street | 49 | 49 | 49 | 49 | 49 |
| 12 | Monsignor O'Brien Highway at East Street/ Cambridge Street | 49 | 47 | 47 | 48 | 47 |
| 13 | Cambridge Street at First Street | 49 | 48 | 48 | 48 | 47 |
| 14 | Monsignor O'Brien Highway at Charlestown Avenue/Land Boulevard | 51 | 50 | 50 | 51 | 49 |

Source: Vanasse Hangen Brustlin, Inc. 2010.

1 The concentrations are expressed in micrograms per cubic meter ($\mu g/m^3$). The background concentrations assumed for the 24-Hour $PM_{10}$ was 45.7 $\mu g/m^3$. The NAAQS for $PM_{10}$ is 150 $\mu g/m^3$. The emissions presented represent the highest emissions experienced at each intersection for each alternative. The air quality study assumes that if this intersection meets the NAAQS, then all other intersections, regardless of alternative, which would have lower volumes and better LOS, can be assumed to also meet the NAAQS.

2 The Proposed Action used for the air quality analysis include the physical and operational mitigation proposed to improve traffic operations (as outlined in Section 6.5, *Traffic and Transportation Systems*) which is based on the updated CTPS statewide traffic model, August 2010. In addition, the *MOBILE* emission factors were updated to the latest available information in October 2010.

3 Figure 5.7-1 shows the intersections evaluated.

## Microscale $PM_{2.5}$ Emissions Results

Tables 6.6-5 and 6.6-6 present the results of the microscale analysis for the 24-hour and annual $PM_{2.5}$, respectively. The predicted Proposed Action (2015) 24-hour $PM_{2.5}$ concentrations range from a minimum of 30.5 μg/m$^3$ to a maximum of 31.7 μg/m$^3$. All of the predicted 24-hour $PM_{2.5}$ concentrations are below the $PM_{2.5}$ NAAQS of 35 μg/m$^3$. The Proposed Action (2015) annual $PM_{2.5}$ concentrations range from a minimum of 11.8 μg/m$^3$ to a maximum of 12.1 μg/m$^3$. All of the annual $PM_{2.5}$ concentrations would be well below the $PM_{2.5}$ NAAQS of 15 μg/m$^3$.

The predicted Proposed Action (2030) 24-hour $PM_{2.5}$ concentrations ranged from a minimum of 30.1 μg/m$^3$ to a maximum of 31.3 μg/m$^3$. All of the predicted 24-hour $PM_{2.5}$ concentrations are below the $PM_{2.5}$ NAAQS of 35 μg/m$^3$. The Proposed Action (2030) annual $PM_{2.5}$ concentrations range from a minimum of 11.8 μg/m$^3$ to a maximum of 12.0 μg/m$^3$. All of the annual $PM_{2.5}$ concentrations would be well below the $PM_{2.5}$ NAAQS of 15 μg/m$^3$.

### Table 6.6-5 Predicted Maximum 24-Hour $PM_{2.5}$ Concentrations (Parts Per Million) [1, 2]

| Intersection Number and Intersection [3] | | 2007 | 2015 | | 2030 | |
|---|---|---|---|---|---|---|
| | | Existing Condition | No-Build Alternative | Proposed Action | No-Build Alternative | Proposed Action |
| 1 | Mystic Valley Parkway at Boston Avenue | 31.7 | 30.9 | 30.9 | 30.5 | 30.5 |
| 2 | Mystic Valley Parkway at Winthrop Street | 32.9 | 31.3 | 31.3 | 30.9 | 30.9 |
| 3 | Mystic Valley Parkway Eastbound off-ramp at Main Street and South Street | 31.7 | 30.9 | 30.9 | 30.5 | 30.9 |
| 4 | Boston Avenue at College Avenue | 31.3 | 30.5 | 30.5 | 30.5 | 30.5 |
| 5 | Harvard Street at Main Street | 31.3 | 30.5 | 30.5 | 31.3 | 31.3 |
| 6 | Medford Street at Broadway and Dexter Street | 31.7 | 30.5 | 30.5 | 30.5 | 30.5 |
| 7 | Highland Street at Central Street | 30.9 | 30.5 | 30.5 | 30.5 | 30.1 |
| 8 | School Street at Medford Street | 31.3 | 30.5 | 30.5 | 30.5 | 30.5 |
| 9 | Somerville Avenue at Washington and Prospect Street | 32.5 | 31.3 | 31.3 | 30.9 | 30.9 |
| 10 | Washington Street at McGrath Highway | 32.1 | 30.9 | 30.9 | 30.5 | 30.5 |
| 11 | Monsignor O'Brien Highway at Third Street | 32.1 | 31.3 | 31.3 | 30.9 | 30.9 |
| 12 | Monsignor O'Brien Highway at East Street/ Cambridge Street | 31.7 | 30.5 | 30.5 | 30.5 | 30.5 |
| 13 | Cambridge Street at First Street | 31.3 | 30.5 | 30.5 | 30.5 | 30.5 |
| 14 | Monsignor O'Brien Highway at Charlestown Avenue/Land Boulevard | 33.3 | 31.7 | 31.7 | 31.3 | 31.3 |

Source: Vanasse Hangen Brustlin, Inc. 2010.

1 The concentrations are expressed in micrograms per cubic meter (μg/m$^3$). The background concentrations assumed for the 24-Hour $PM_{2.5}$ was 29.7 μg/m$^3$. The NAAQS for $PM_{2.5}$ is 35 μg/m$^3$. The emissions presented represent the highest emissions experienced at each intersection for each alternative. The air quality study assumes that if this intersection meets the NAAQS, then all other intersections, regardless of alternative, which would have lower volumes and better LOS, can be assumed to also meet the NAAQS.

2 The Proposed Action used for the air quality analysis include the physical and operational mitigation proposed to improve traffic operations (as outlined in Section 6.5, *Traffic and Transportation Systems*) which is based on the updated CTPS statewide traffic model, August 2010. In addition, the *MOBILE* emission factors were updated to the latest available information in October 2010.

3 Figure 5.7-1 shows the intersections evaluated.

**Table 6.6-6 Predicted Maximum Annual $PM_{2.5}$ Concentrations (Parts Per Million) [1, 2]**

| Intersection Number and Intersection [3] | 2007 Existing Condition | 2015 No-Build Alternative | 2015 Proposed Action | 2030 No-Build Alternative | 2030 Proposed Action |
|---|---|---|---|---|---|
| 1 Mystic Valley Parkway at Boston Avenue | 12.1 | 11.9 | 11.9 | 11.9 | 11.9 |
| 2 Mystic Valley Parkway at Winthrop Street | 12.3 | 12.0 | 12.0 | 11.9 | 11.9 |
| 3 Mystic Valley Parkway Eastbound off-ramp at Main Street and South Street | 12.1 | 11.9 | 11.9 | 11.9 | 11.9 |
| 4 Boston Avenue at College Avenue | 12.0 | 11.9 | 11.9 | 11.9 | 11.9 |
| 5 Harvard Street at Main Street | 12.0 | 11.9 | 11.9 | 12.0 | 12.0 |
| 6 Medford Street at Broadway and Dexter Street | 12.1 | 11.9 | 11.9 | 11.9 | 11.9 |
| 7 Highland Street at Central Street | 11.9 | 11.8 | 11.8 | 11.8 | 11.8 |
| 8. School Street at Medford Street | 12.0 | 11.9 | 11.9 | 11.9 | 11.9 |
| 9 Somerville Avenue at Washington and Prospect Street | 12.3 | 12.0 | 12.0 | 11.9 | 11.9 |
| 10 Washington Street at McGrath Highway | 12.2 | 11.9 | 11.9 | 11.9 | 11.9 |
| 11 Monsignor O'Brien Highway at Third Street | 12.2 | 12.0 | 12.0 | 11.9 | 11.9 |
| 12 Monsignor O'Brien Highway at East Street/ Cambridge Street | 12.1 | 11.9 | 11.9 | 11.9 | 11.9 |
| 13 Cambridge Street at First Street | 12.0 | 11.9 | 11.9 | 11.9 | 11.9 |
| 14 Monsignor O'Brien Highway at Charlestown Avenue/Land Boulevard | 12.4 | 12.1 | 12.1 | 12.1 | 12.0 |

Source: Vanasse Hangen Brustlin, Inc. 2010.

1 The concentrations are expressed in micrograms per cubic meter ($\mu g/m^3$). The background concentrations assumed for the annual $PM_{2.5}$ was 11.7 $\mu g/m^3$. The NAAQS for $PM_{2.5}$ is 15 $\mu g/m^3$. The emissions presented represent the highest emissions experienced at each intersection for each alternative. The air quality study assumes that if this intersection meets the NAAQS, then all other intersections, regardless of alternative, which would have lower volumes and better LOS, can be assumed to also meet the NAAQS.

2 The Proposed Action used for the air quality analysis include the physical and operational mitigation proposed to improve traffic operations (as outlined in Section 6.5, *Traffic and Transportation Systems*) which is based on the updated CTPS statewide traffic model, August 2010. In addition, the *MOBILE* emission factors were updated to the latest available information in October 2010.

3 Figure 5.7-1 shows the intersections evaluated.

## Microscale Commuter Rail Evaluation

The trains that would be used on the Green Line Extension project would be electric and would not generate air pollution in the project study area. However, a segment of the diesel-powered commuter rail track would be relocated closer to a residential area. The nearest residential property to the proposed MBTA Lowell Line alignment is located at the end of Morton Street near Ball Square Station. The commuter rail track is currently 25 feet from the property line and 33 feet from the nearest residential building. The relocation would result in track being moved to approximately 10 feet from the property line and 18 feet from the nearest residential building. The air quality analysis calculated $PM_{2.5}$ emissions because it represents the most sensitive pollutant to changes in distance.

Table 6.6-7 provides the results of the air quality analysis, which demonstrates that relocating the commuter track closer to the residential area would not result in an adverse air quality impact. The predicted 24-hour $PM_{2.5}$ concentration from train emissions for the existing track location (at both the nearest property line and nearest residential property) would be 29.7 µg/m$^3$. The predicted annual $PM_{2.5}$ concentration from train emissions at both the nearest property line and nearest residential building for the existing track location would be 11.7 µg/m$^3$.

**Table 6.6-7 Projected $PM_{2.5}$ Emissions for Proposed Commuter Rail Track Relocation (µg/m$^3$)**

| | Track Distance From Nearest Residential Property Line | | | Track Distance from Nearest Residential Building | | |
|---|---|---|---|---|---|---|
| | No-Action Alternative (25 feet) | Proposed (10 feet) | Difference | No-Action Alternative (33 feet) | Proposed (18 feet) | Difference |
| 24-Hour $PM_{2.5}$ Concentration[1] | 29.7 | 30.1 | +0.4 | 29.7 | 30.1 | +0.4 |
| Annual $PM_{2.5}$ Concentration[2] | 11.7 | 11.8 | +0.1 | 11.7 | 11.8 | +0.1 |

1 The background concentration for the 24-hour concentration assumed was 29.7 µg/m$^3$. The NAAQS standard for 24-Hour $PM_{2.5}$ is 35 µg/m$^3$.
2 The background concentration assumed for the annual concentration was 11.7 µg/m$^3$. The NAAQS standard for Annual $PM_{2.5}$ is 15 µg/m$^3$.

By relocating the commuter rail tracks approximately 15 feet closer to the nearest property line and residential building, the 24-hour $PM_{2.5}$ concentrations are expected to increase to 30.1 µg/m$^3$ at both the nearest property line and residential building (an increase of 0.4 µg/m$^3$). The annual $PM_{2.5}$ concentrations are expected to increase to 11.8 µg/m$^3$ (an increase of 0.1 µg/m$^3$). The new $PM_{2.5}$ concentrations at both the nearest property line and residential building for the 24-hour (30.1 µg/m$^3$) and annual (11.8 µg/m$^3$) emissions are still below NAAQS standard of 35 µg/m$^3$ and 15 µg/m$^3$ for the 24-hour and annual periods, respectively. All other receptor locations, which would be located further away, would experience even lower concentrations.

### 6.6.6 Mesoscale Analysis

The mesoscale analysis calculated the 2015 and 2030 mobile source emissions from the major roadways in the project study area. The existing VOC and $NO_X$ emissions, estimated to be 55,825 kilograms per day (kg/day) of VOCs and 161,463 kg/day of $NO_X$, establish a baseline to which future emissions can be compared. Table 6.6-8 presents the mesoscale analysis results which include VOCs, $NO_X$, CO, and PM emissions.

Under the 2015 No-Build Alternative, VOC emissions are predicted to be 28,040 kg/day and the $NO_X$ emissions are estimated to be 53,792 kg/day. Similarly, the No-Build Alternative (2030) projected 22,507 kg/day in VOC emission and 20,046 kg/day in $NO_X$ emissions. Table 6.6-8 presents the mesoscale analysis results for all the pollutants.

The results of the mesoscale analysis demonstrate that the Proposed Action would reduce emissions of VOC, $NO_X$, $PM_{10}$, $PM_{2.5}$, and CO as compared to the No-Build Alternative. The most notable is the VOC emission reduction of 23,807 kg/day and 25,728 kg/day for the Proposed Action in 2015 and 2030, respectively. Figure 6.6-1 illustrates the differences in emissions between the various alternatives for each of the mesoscale pollutants.

As Table 6.6-8 and Figure 6.6-1 show, the No-Build Alternative and the Proposed Action in 2015 and 2030 would be consistently lower in emission for VOCs, $NO_X$, and $PM_{10}$ than existing conditions.

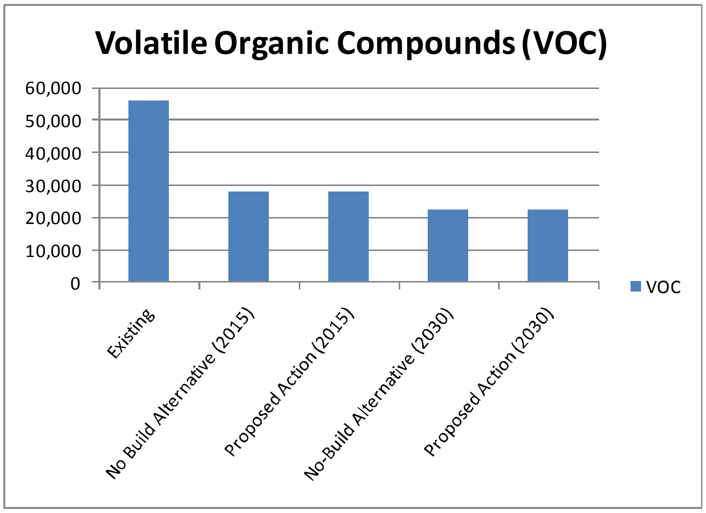
The air quality study demonstrates that the Proposed Action for the proposed Green Line Extension project complies with the CAAA. The ozone mesoscale analysis demonstrates that the Proposed Action would result in a decrease of VOC, $NO_X$, $PM_{10}$, $PM_{2.5}$, and CO emissions, as compared to the No-Build Alternative under both 2015 and 2030 conditions.

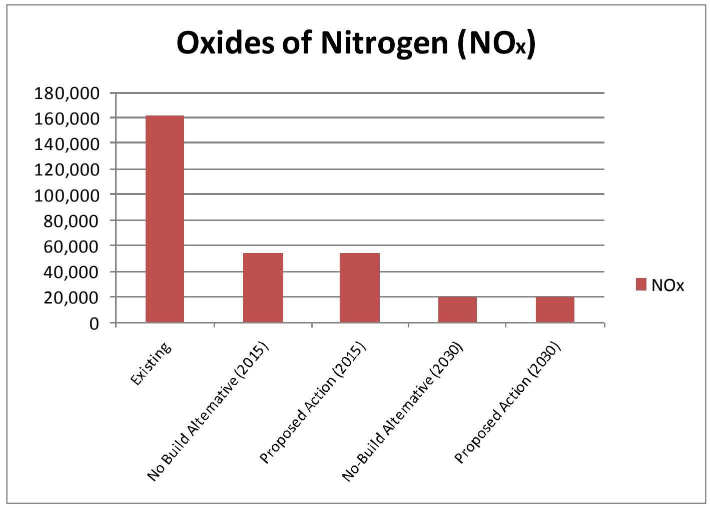
**Table 6.6-8 Mesoscale Mobile Source Analysis Results (kilograms per day)[1]**

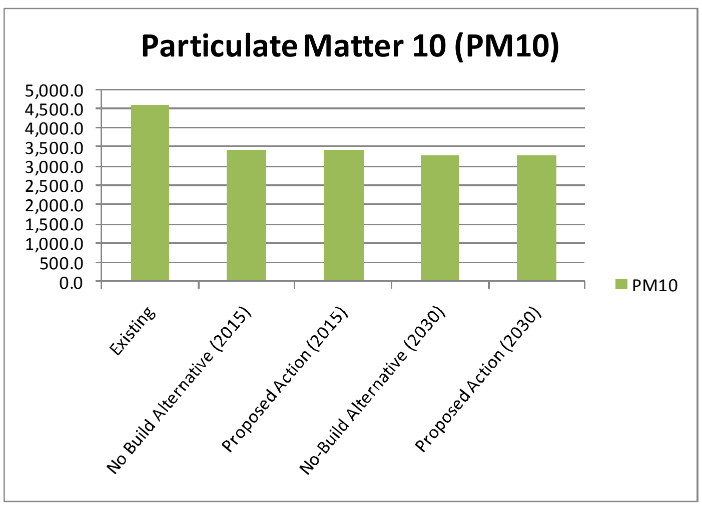
| Condition[2] | Vehicle Miles Traveled (VMT)[3] | Volatile Organic Compounds (VOCs) | Nitrogen Oxides ($NO_x$) | Particulate Matter 10 ($PM_{10}$) | Particulate Matter 2.5 ($PM_{2.5}$) | Carbon Monoxide (CO) |
|---|---|---|---|---|---|---|
| Existing Condition (2007) | 105,264,275 | 55,825 | 161,463 | 4,578 | 2,892 | 1,465,221 |
| No-Build Alternative (2015) | 110,738,922 | 28,040 | 53,792 | 3,439 | 1,778 | 1,093,898 |
| Proposed Action (2015) | 110,715,115 | 28,033 | 53,781 | 3,438 | 1,777 | 1,093,672 |
| Difference | -23,807 | -7 | -11 | -1 | -1 | -226 |
| No-Build Alternative (2030) | 119,184,452 | 22,507 | 20,046 | 3,272 | 1,520 | 1,053,770 |
| Proposed Action (2030) | 119,158,724 | 22,499 | 20,042 | 3,272 | 1,519 | 1,053,521 |
| Difference | -25,728 | -8 | -4 | Neg` | -1 | -249 |

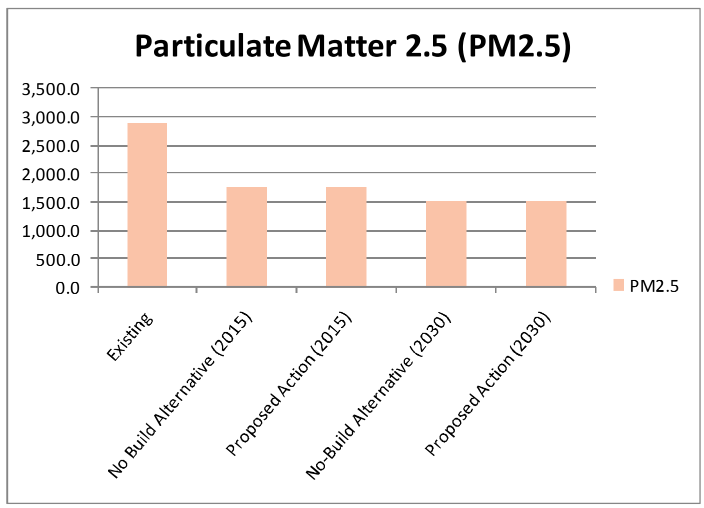
1 Based on the updated CTPS statewide traffic model, August 2010.
2 The Proposed Action used for the air quality analysis includes the physical and operational mitigation proposed to improve traffic operations (as outlined in Section 6.5, *Traffic and Transportation Systems*).
3 VMT represents the vehicle miles traveled on an average weekday.

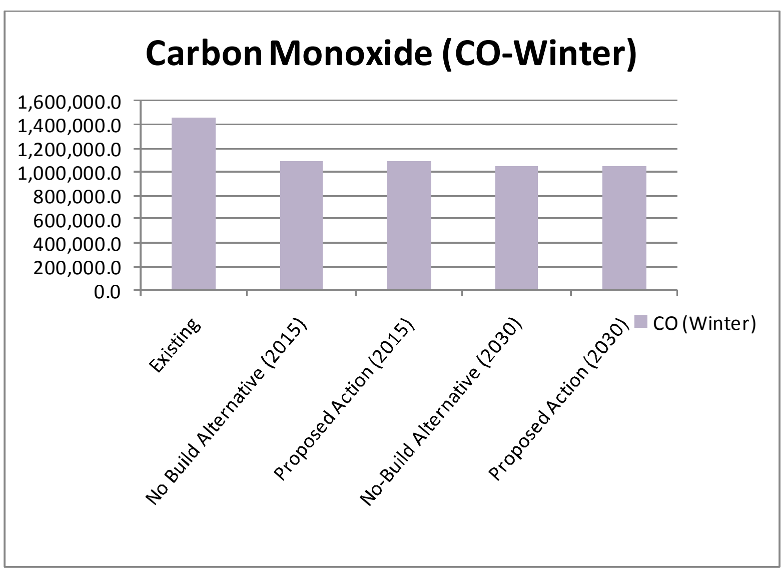
**Figure 6.6-1 Mesoscale Mobile Source Analysis Results (kilograms per day)**



### 6.6.7 Greenhouse Gas ($CO_2$) Analysis

The EEA has developed a policy that requires a project to evaluate GHG emissions. The air quality study calculated the GHG emissions from mobile sources related to the proposed Green Line Extension project. While GHG emissions include several gases, $CO_2$ was selected for evaluation because it is the most important component of transportation-related GHG emissions. The GHG mobile source analysis traffic (volumes, delays, and speeds) and emission factor data were developed for:

- Existing Conditions (2007)
- No-Build Alternative (2015)
- Proposed Action (2015)
- No-Build Alternative (2030)
- Proposed Action (2030)

The GHG mobile source analysis was conducted following procedures similar to the ozone mesoscale analysis. The changes in $CO_2$ emissions from traffic were based on the average daily traffic volumes, roadway lengths, and vehicle emissions factors for existing and new trips for weekday and weekend conditions. The mesoscale analysis estimated the future project study area $CO_2$ emissions due to the changes in traffic and emission data. Table 6.6-9 presents a summary of the $CO_2$ emissions projected for the No-Build Alternative and the Proposed Action in 2015 and 2030. For the No-Build Alternative in 2015 and 2030, $CO_2$ emissions were estimated to be 62,575,776 kg/day and 67,891,290 kg/day, respectively. The Proposed Action provides large $CO_2$ emission reductions with a reduction of 13,619 kg/day under 2015 conditions and 17,682 kg/day under 2030 conditions.

**Table 6.6-9 Greenhouse Gas (CO2) Analysis Results (kilograms per day)[1]**

| Condition[2] | Carbon Dioxide ($CO_2$) | Change from No-Build Alternative |
|---|---|---|
| Existing Condition | 58,128,707 | - |
| No-Build Alternative (2015) | 62,575,776 | - |
| Proposed Action (2015) | 62,562,157 | -13,619 |
| No-Build Alternative (2030) | 67,891,290 | - |
| Proposed Action (2030) | 67,873,609 | -17,682 |

1 Based on the updated CTPS statewide traffic model, August 2010.
2 The Proposed Action used for the air quality analysis includes the physical and operational mitigation proposed to improve traffic operations (as outlined in the traffic section).

### 6.6.8 Air Toxics

The air quality study evaluated the potential for increases in air toxics due to the project. Most air toxics originate from human-made sources, including on-road mobile sources, non-road mobile sources (*e.g.*, airplanes), area sources (*e.g.*, dry cleaners) and stationary sources (*e.g.*, factories or refineries).

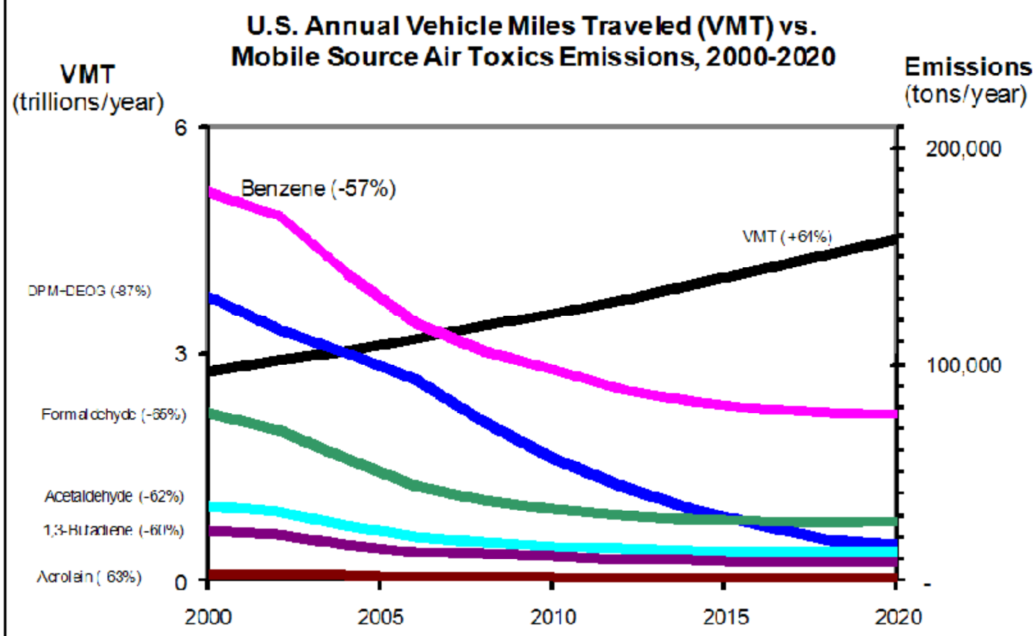
Mobile Source Air Toxics (MSATs) are a subset of the 188 air toxics defined by the Clean Air Act. The MSATs are compounds emitted from highway vehicles and non-road equipment. Some toxic compounds are present in fuel and are emitted to the air when the fuel evaporates or passes through the engine unburned. Other toxics are emitted from the incomplete combustion of fuels or as secondary combustion products. Metal air toxics also result from engine wear or from impurities in oil or gasoline.

The EPA is the lead Federal agency for administering the Clean Air Act and has certain responsibilities regarding the health effects of MSATs. Under the authority in Section 202 of the Clean Air Act, the EPA issued a *Final Rule on Controlling Emissions of Hazardous Air Pollutants from Mobile Sources: 66 FR 17229* (March 29, 2001). In its rule, EPA examined the impacts of existing and newly promulgated mobile source control programs, including its reformulated gasoline (RFG) program, its national low emission vehicle (NLEV) standards, its Tier 2 motor vehicle emissions standards and gasoline sulfur control requirements, and its proposed heavy duty engine and vehicle standards and on-highway diesel fuel sulfur control requirements. Between 2000 and 2020, these programs, even with a 64 percent increase in VMT, are expected to reduce on-highway emissions of benzene, formaldehyde, 1,3-butadiene, and acetaldehyde by 57 to 65 percent, and to reduce on-highway diesel PM emissions by 87 percent, as shown in Figure 6.6-2.

As a result, EPA concluded that no additional motor vehicle emissions standards or fuel standards were necessary to further control MSATs. However, the agency is preparing another rule under authority of CAA Section 202(l) that would address these issues further and could make adjustments to MSATs.

The available technical tools do not allow the project-specific health impacts of the emission changes associated with the Proposed Action to be predicted. Due to these limitations, the following discussion is included in accordance with the CEQ regulations (40 CFR 1502.22(b)) regarding incomplete or unavailable information.

## Figure 6.6-2 Mobile Source Air Toxics Emissions




Notes: For on road mobile sources. Emissions factors were generated using MOBILE6.2. MTBE proportion of market for oxygenates is held constant, at 50%. Gasoline RVP and oxygenate content are held constant. VMT: *Highway Statistics 2000*, Table VM-2 for 2000, analysis assumes annual growth rate of 2.5%. "DPM + DEOG" is based on MOBILE6.2-generated factors for elemental carbon, organic carbon and SO4 from diesel-powered vehicles, with the particle size cutoff set at 10.0 microns.

Evaluating the environmental and health impacts from MSATs on proposed transit would involve several key elements, including emissions modeling, dispersion modeling in order to estimate ambient concentrations resulting from the estimated emissions, exposure modeling in order to estimate human exposure to the estimated concentrations, and then final determination of health impacts based on the estimated exposure. Each of these steps is encumbered by technical shortcomings or uncertain science that prevents a more complete determination of the MSAT health impacts of the project.

- **Emissions**: The EPA tools to estimate MSAT emissions from motor vehicles are not sensitive to key variables determining emissions of MSATs in the context of highway projects. While MOBILE6.2 is used to predict emissions at a regional level, it has limited applicability at the project level. MOBILE6.2 is a trip-based model. The emission factors are projected based on a typical trip of 7.5 miles, and on average speeds for this typical trip. This means that MOBILE6.2 does not have the ability to predict emission factors for a specific vehicle operating condition at a specific location at a specific time. Because of this limitation, MOBILE6.2 can only approximate the operating speeds and levels of congestion likely to be present on the largest-scale projects, and cannot adequately capture emissions effects of smaller projects. For PM, the model results are not sensitive to average trip speed, although the other MSAT emission rates do change with changes in trip speed. Also, the emissions rates used in MOBILE6.2 for both PM and MSATs are based on a limited number of tests of mostly older-technology vehicles. Lastly, in its discussions of PM under the conformity rule, EPA has identified problems with MOBILE6.2 as an obstacle to quantitative analysis. These deficiencies compromise the capability of MOBILE6.2 to estimate MSAT emissions. MOBILE6.2 is an adequate tool for projecting emissions trends, and performing relative analyses between conditions for very large projects, but it is not sensitive enough to capture the effects of travel changes tied to smaller projects or to predict emissions near specific roadside locations.

- **Dispersion**: The tools to predict how MSATs disperse are also limited. The EPA's current regulatory models, CALINE3 and CAL3QHC, were developed and validated more than a decade ago for the purpose of predicting episodic concentrations of CO to determine compliance with the NAAQS. The performance of dispersion models is more accurate for predicting maximum concentrations that can occur at some time at some location within a geographic area. This limitation makes it difficult to predict accurate exposure patterns at specific times at specific highway project locations across an urban area to assess potential health risk. The National Cooperative Highway Research Program (NCHRP) is conducting research on best practices in applying models and other technical methods in the analysis of MSATs. This work also would focus on identifying appropriate methods of documenting and communicating MSAT impacts in the NEPA process and to the general public. Along with these general limitations of dispersion models, the FTA is also faced with a lack of monitoring data in most areas for use in establishing project-specific MSAT background concentrations.
- **Exposure Levels and Health Effects**: Even if emission levels and concentrations of MSATs could be accurately predicted, shortcomings in current techniques for exposure assessment and risk analysis preclude meaningful conclusions about project-specific health impacts. Exposure assessments are difficult because it is difficult to accurately calculate annual concentrations of MSATs near roadways, and to determine the portion of a year that people are actually exposed to those concentrations at a specific location. These difficulties are magnified for 70-year cancer assessments, particularly because unsupportable assumptions would have to be made regarding changes in travel patterns and vehicle technology (which affects emissions rates) over a 70-year period. There are also considerable uncertainties associated with the existing estimates of toxicity of the various MSATs, because of factors such as low-dose extrapolation and translation of occupational exposure data to the general population. Because of these shortcomings, any calculated difference in health impacts between each of the project conditions is likely to be much smaller than the uncertainties associated with calculating the impacts. Consequently, the results of such assessments would not be useful to decision makers, who would need to weigh this information against other project impacts that are better suited for quantitative analysis.

Research into the health impacts of MSATs is ongoing. For different emission types, there are a variety of studies that show that some either are statistically associated with adverse health outcomes through epidemiological studies (frequently based on emissions levels found in occupational settings) or that animals demonstrate adverse health outcomes when exposed to large doses.

Exposure to toxics has been a focus of a number of EPA efforts. Most notably, the agency conducted the National Air Toxics Assessment (NATA) in 1996 to evaluate modeled estimates of human exposure applicable to the county level. While not intended for use as a measure of or benchmark for local exposure, the modeled estimates in the NATA database best illustrate the levels of various toxics when aggregated to a national or state level.

The EPA is in the process of assessing the risks of various kinds of exposures to these pollutants. The EPA Integrated Risk Information System (IRIS) is a database of human health effects that could result from exposure to various substances found in the environment. The IRIS database can be found online at http://www.epa.gov/iris. The following toxicity information for the six prioritized MSATs was taken from the IRIS database Weight of Evidence Characterization summaries. This information is taken from EPA's IRIS database and represents EPA's most current evaluations of the potential hazards and toxicology of these chemicals or mixtures. These chemicals and mixtures include:

- Benzene;
- Acrolein;
- Formaldehyde;
- 1,3-butadiene;
- Acetaldehyde; and
- Diesel exhaust.

As discussed above, technical shortcomings of emissions and dispersion models and uncertain science with respect to health effects prevent meaningful or reliable estimates of MSAT emissions and effects of the project. However, even though reliable methods do not exist to accurately estimate the health impacts of MSATs at the project level, it is possible to qualitatively assess the levels of future MSAT emissions under the project. Although a qualitative analysis cannot identify and measure health impacts from MSATs, it can give a basis for identifying and comparing the potential differences among MSAT emissions—if any—from the various conditions. The qualitative assessment presented below is derived in part from a study conducted by the FHWA.[12]

12 United States Department of Transportation, Federal Highway Administration. *A Methodology for Evaluating Mobile Source Air Toxic Emissions Among Transportation Project Alternatives.* Available at: www.fhwa.dot.gov/environment/airtoxic/msatcompare/msatemissions.html.

For the Proposed Action in 2015 and 2030, the amount of MSATs emitted would be proportional to the VMT, assuming that other variables such as fleet mix are the same for each alternative. The VMT for the No-Build Alternative and the Proposed Action in 2015 and 2030 are presented earlier in Table 6.6-8. The VMT estimated for the Proposed Action in 2015 and 2030 are lower than that for the corresponding No-Build Alternative, because the extension of the Green Line would remove vehicles (and therefore reduce VMT) from the project study area roadways by shifting mode choice to public transportation (*i.e.*, the Green Line). This reduction in VMT would lead to lower MSAT emissions for the Proposed Action in 2015 and 2030.

Emissions would likely be lower than present levels in the design year as a result of EPA's national emissions control programs that are projected to reduce MSAT emissions by 57 to 87 percent between 2000 and 2020. Local conditions could differ from these national projections in terms of fleet mix and turnover, VMT growth rates, and local control measures. However, the magnitude of the EPA-projected reductions is so great (even after accounting for VMT growth) that MSAT emissions in the project study area are likely to be lower in the future in all cases.

### 6.6.9 Metropolitan Planning and Air Quality Conformity

The proposed Green Line Extension project is included in the current (FY11-FY14) State Transportation Improvement Program (STIP). The project is required by the SIP. The Massachusetts Air Pollution Control Regulations (310 CMR 7.36) require that MassDOT complete the project by December 31, 2014.

The TIP is an agreed-upon scheduled list of specific, prioritized transportation projects in the Boston region. The TIP is managed by the Boston Region MPO. An MPO-endorsed TIP is incorporated into the STIP, which is distributed to the FHWA, FTA, and EPA for certification before the end of each Federal fiscal year (September 30). The TIP lists all transportation projects programmed to receive Federal funds over a four-year horizon and all projects programmed with Federal and state highway funds that are expected to be available. Eligible project categories are bridges, roads, bicycle facilities, and pedestrian and streetscape improvements. The TIP is financially constrained; the MPO can only include projects for which funds are expected to be available.

The MPO has defined the overall framework for TIP programming and created project selection criteria. Criteria are used on existing conditions, safety, mobility, cost effectiveness, economic development, land use, and community impact. The most current TIP and Air Quality Conformity Determination available are for the fiscal years 2010-2013. The Green Line Extension project is included in the TIP under the Air Conformity section of the report (Chapter 4). The Green Line Extension project was submitted as a transportation control measures as a SIP commitment as part of the Central Artery/Tunnel mitigation as "Green Line Extension to Medford Hillside."

The SIP is a list of statewide intermodal program of transportation projects funded by the FHWA or FTA, which are consistent with the Statewide Long Range Transportation Plan and the Massachusetts Transportation Improvement Program. For the Regional Transportation Plan and TIP, conformity is determined in relation to the SIP mobile source emission budgets.

The Massachusetts Transit System Improvements regulation (310 CMR 7.36) became effective in December 1991 and was incorporated into the Massachusetts SIP in October 1994.[13] This regulation specified transit system improvement projects deemed necessary to mitigate the air quality impacts of the Central Artery/Third Harbor Tunnel project. While a number of projects included in 310 CMR 7.36 were completed, several transit system improvement projects (Green Line Arborway Restoration, the Blue Line Connection from Bowdoin Station to the Red Line at Charles Station, and the Green Line Extension to Ball Square/Tufts University) were delayed and it was determined would not be completed within the required SIP timeframes. MassDOT (formerly Executive Office of Transportation and Public Works (EOTPW)) and MassDEP established an Administrative Consent Order (ACO) in 2000 that addressed revised schedules for implementation. The ACO was revised in 2002 and 2005 to address additional compliance issues.

310 CMR 7.36, as adopted in 1991, included a substitution process for changing projects that are included in the regulation and the approved SIP. In 2005, EOTPW initiated the process for the substitution of the original SIP projects with a new package of projects which included an extension of the Green Line to Medford with a spur to Union Square, improvements to the Fairmount Line, and the construction of an additional 1,000 Park and Ride spaces. Following a public process on the proposed substitute projects, EOTPW submitted a request to MassDEP to revise the 310 CMR 7.36 and the SIP.[14] Air quality modeling was done for these projects in 2006 with results shown in Table 6.6-10, demonstrating that the package of substitution projects would – as required – achieve a minimum of 110 percent of the emissions reductions that would have been achieved if the original SIP projects had been built relative to a common No-Build scenario for the year 2025. The No-Build scenario for the 2006 SIP analysis included highway and transit projects that were included in the 2030 Regional Transportation Plan for the Boston MPO No-Build scenario in the JOURNEY TO 2030 Plan.[15]

13 Federal Register (59 FR 50495-50498). October 4, 1994, *SIP Approved Projects Plus Ten Percent Package*.
14 Massachusetts Department of Transportation adopted revisions to 310 CMR 7.36 on December 1, 2006 and submitted State Implementation Plan revisions to the United States Environmental Protection Agency.
15 Boston Metropolitan Planning Organization. *Journey to 2030 – Amendment, Transportation Plan of the Boston Region Metropolitan Planning Organization*, November 19, 2009. Available at: http://www.ctps.org/bostonmpo/3_programs/1_transportation_plan/2030Tranplan_toc.pdf

**Table 6.6-10 Air Quality Analysis Comparison of Project Packages Benefits in the Year 2025**

| | Daily Emissions Benefits in Kilograms (kg) | | |
|---|---|---|---|
| | Carbon Monoxide (CO) | Nitrogen Oxides (NOx) | Volatile Organic Compounds (VOCs) |
| SIP Approved Projects (Package): Arborway; Green Line Extension to Ball Square/ Tufts; Blue Line/Red Line Connection (Bowdoin Station to Charles/MGH Station) | 292 | 8 | 11 |
| SIP Approved Projects (Package) Plus Ten Percent | 321.2 | 8.8 | 12.1 |
| Replacement/Substitution Projects (Package): Green Line Extension to Union Square and Medford, Fairmont Line Improvements, and Additional Parking | 435 | 11 | 17 |

On July 31, 2008, the EPA approved the SIP revision that had been submitted by the Commonwealth of Massachusetts.[16] This revision updates the list of required transit projects, changes the completion dates for the delayed transit projects, provides interim deadlines for projects, maintains requirements for interim emission reduction offsets in the event a project becomes delayed, modifies the project substitution process, and expands public participation in and oversight of the required projects.

A number of different alternatives for the Green Line Extension were examined. However, the air quality results could not be compared to the Table 6.6-10 values because the analyses initially prepared were relative to a different No-Build scenario than that used in the 2006 SIP analysis. The 2006 SIP Analysis No-Build scenario included projects such as the Urban Ring, Silver Line Phase III, Blue Line Extension to Lynn, and South Coast Rail, which were not incorporated into the 2009 No-Build scenario. As MassDOT plans to seek Federal funding for the project, the Green Line Extension No-Build scenario was chosen based on requirements of the FTA to reflect the most reasonable project commitments given the state's current financial condition. Therefore, the air quality analysis is not comparable to the one done in 2006, based on the differences in the No-Build scenarios. Other differences between the 2006 SIP analysis and this Green Line Extension analysis include:

- The 2009 CTPS travel demand model used to conduct the air quality analysis has been modified since 2006. The 2009 version of the travel demand model was updated to include a roadway network and land use data that was more recent than was used in the 2006 version of the travel demand model. Furthermore, enhancements have been made to the model since 2006 to improve its predictive ability.
- The current analysis uses the most current land use from the last adopted Regional Transportation Plan. This input produces fewer home-based trips than the 2006 study showed for the 2030 forecast year, resulting in slightly less demand for the proposed extension of the Green Line to areas further away from Boston.

16 Federal Register/Vol. 73, No. 148/Thursday, July 31, 2008/Rules and Regulations, Environmental Protection Agency, 40 CFR Part 52 (EPA-R01-OAR-2006-1018; A-1-FRL-8691-5). Available at: http://greenlineextension.eot.state.ma.us/documents/RelRegulatory/EPA-R01-OAR-2006-1018-0061.pdf

- Emission factors for pollutants have changed over time as EPA has refined its MOBILE air quality model. Each SIP analysis was performed using the most current set of emission factors available at the time.

In order to conduct a fair comparison of air quality benefits associated with the package of approved SIP projects, CTPS created a No-Build scenario in accordance with the latest 2009 assumptions but used a comparative process to ascertain air quality benefits that is equivalent to the one used in the 2006 SIP analysis. This No-Build scenario was compared to a Build scenario that includes the following transit improvements:

- The Proposed Action;
- Fairmont Commuter Rail Improvements (four new stations and off-peak headway improvements); and
- Parking expansions totaling at least 1,000 parking spaces in the Boston Region.

The findings of this analysis, using a methodology consistent with the 2006 SIP analysis, show that the proposed package of transit improvements exceeds the 110 percent threshold that was required for CO, $NO_X$, and VOCs. The proposed Green Line Extension project represents the majority of the air quality benefits that are being forecasted for the package of improvements included in the 2009 SIP analysis, as shown in Table 6.6-11.

Based upon this evaluation, the emission reductions from the proposed Green Line Extension project equal or exceed the emission reductions projected in the air quality modeling done in 2006.

**Table 6.6-11 Comparison of Air Quality Benefits**

| | Daily Emissions Benefits in Kilograms (kg) | | |
|---|---|---|---|
| | Carbon Monoxide (CO) | Nitrogen Oxides (NOx) | Volatile Organic Compounds (VOC) |
| 2006 Approved Package of Projects: Arborway; Green Line Extension to Ball Square/ Tufts; Blue Line/Red Line Connection | 292 | 8 | 11 |
| 2008 Federal Register SIP Approved Projects + 10% | 321.2 | 8.8 | 12.1 |
| 2009 Package: Green Line Extension to College Avenue with Union Square Spur; Fairmount; Parking | 520 | 9.5 | 16 |
| 2009 Analysis – Green Line Extension Only Benefits | 443 | 8.5 | 13 |
| Percent of Green Line Extension Benefits as compared to Total Package | 85% | 89% | 81% |

### 6.6.10 Consistency with the SIP

The Green Line Extension project is a requirement of the SIP[17] and the Massachusetts Air Pollution Control Regulations (310 CMR 7.36), which implement the SIP, require that MassDOT complete the project by December 31, 2014. The transit regulations (310 CMR 7.36) specify transit system improvement projects designed to increase transit ridership and improve regional air quality. These regulations, among several others, were incorporated into the Massachusetts SIP.[18]

The current projects required under the transit regulations but yet to be completed include an extension of the Green Line to Medford with a spur to Union Square, improvements to the Fairmount Line, and the construction of 1,000 Park and Ride parking spaces as well as the design (only) of the Red Line/Blue Line Connector in Boston. In March 2007, as required by the transit regulations, MassDOT submitted to the DEP and the EPA, a report summarizing the air quality modeling performed for these projects.

In 2009, at the request of MassDOT, CTPS conducted an updated air quality analysis of the currently-proposed Green Line Extension to College Avenue with Union Square Spur in combination with the proposed Fairmount Line improvements and additional MBTA parking, as required by 310 CMR 7.36(2). The MassDEP reviewed this air quality analysis and stated in their January 8, 2010 and July 9, 2010 MEPA comment letters that the Green Line Extension project meets the emission reductions for 310 CMR 7.36 (8) *Determination of Air Quality Emission Reductions*, which are the requirements of the SIP.

On July 27, 2011, MassDOT and the MBTA announced that the Green Line Extension project was projected to be completed within a timeframe of September 2018 to July 2020. This timeline represents a substantial delay beyond the current SIP deadline of December 31, 2014, triggering the need to provide interim emission reduction offset projects and measures for the period of the delay (beginning January 1, 2015). Working with the CTPS, MassDOT and the MBTA are currently initiating the process of calculating the reductions of non-methane hydrocarbons, CO, and $NO_X$ – reductions equal to or greater than the reductions projected for the Green Line Extension itself, as specified in the SIP regulation – that will be required for the period of the delay. Once that process is complete, MassDOT and the MBTA will develop a portfolio of interim projects and/or measures that can meet the requirement, and will seek input from both MassDEP and the general public on the portfolio.

MassDOT and the MBTA are aware of the strong public interest in potential interim emission reduction offsets, having already received many suggestions and

17 The State Implementation Plan (SIP) includes a list of transportation projects funded by the FHWA or the FTA, which are consistent with the Statewide Long Range Transportation Plan and the Massachusetts TIP that are needed to meet the NAAQS.

18 Ibid.

recommendations; MassDOT and MBTA will strive to make use of ideas presented to us by the public whenever possible. However, MassDOT and the MBTA are acutely aware of the need for any selected interim emission reduction offsets to quantitatively and demonstrably meet the emission reduction threshold established in the SIP regulation, and will be subjecting potential interim emission reduction offsets to necessary rigorous analysis by the CTPS. MassDOT and the MBTA are also sensitive to the constrained fiscal environment in which all of the Massachusetts transportation agencies currently operate, and will weigh fiscal concerns when selecting appropriate interim emission reduction offsets. Once identified, the mitigation projects will be submitted to MassDEP for revision to the transit regulations and SIP.

### 6.6.11 Transportation Improvement Program and Air Quality Conformity Determination Summary

The project meets the Transportation Conformity planning-level conformity requirements because the Green Line Extension project is part of an approved SIP. The project meets the Transportation Conformity project-level conformity requirements because it includes an air quality analysis using MOBILE6.2 and CAL3QHC demonstrating that it meets the NAAQS. The air quality analyses conducted and presented in this EA indicate that the Proposed Action would result in concentrations of regulated air pollutants well below the NAAQS. The emissions for the Proposed Action in 2015 and 2030 reviewed for both the mesoscale (VOC, $NO_X$, and $PM_{10}$) and the microscale (CO, $PM_{2.5}$, and $PM_{10}$) analyses would be below the NAAQS requirements. Overall, the Proposed Action will result in a reduction in emissions for each of the assessed pollutants of concern.

## 6.7 Noise

This section provides the impacts analysis for noise. Appendix F *Noise and Vibration Technical Report*, provides the full noise analysis.[19] Figure 6.7-1 shows an overview of the measurement sites and proposed noise mitigation locations. Figures 6.7-2 through 6.7-6 show those locations that would be impacted by noise, as well as the proposed mitigation measures discussed in further detail in Chapter 7, *Project and Mitigation Commitments*, of this EA.

### 6.7.1 Noise Impact Assessment Methodology

The noise impact assessment methodology involves identifying noise-sensitive land uses, conducting measurements of existing noise levels in the community, projecting future noise levels from the Proposed Action, assessing potential impact and

19 Harris Miller Miller and Hanson, Inc. *Massachusetts Bay Transportation Authority Green Line Extension Noise and Vibration Technical Report, Environmental Assessment*, August 2011.

determining the need, feasibility, reasonableness and effectiveness of mitigation measures. This section describes the categories of noise-sensitive land use specified by the FTA, the noise impact criteria used to assess impact, and a summary of the principal assumptions used in projecting future noise levels from transit sources.

## Noise Impact Criteria

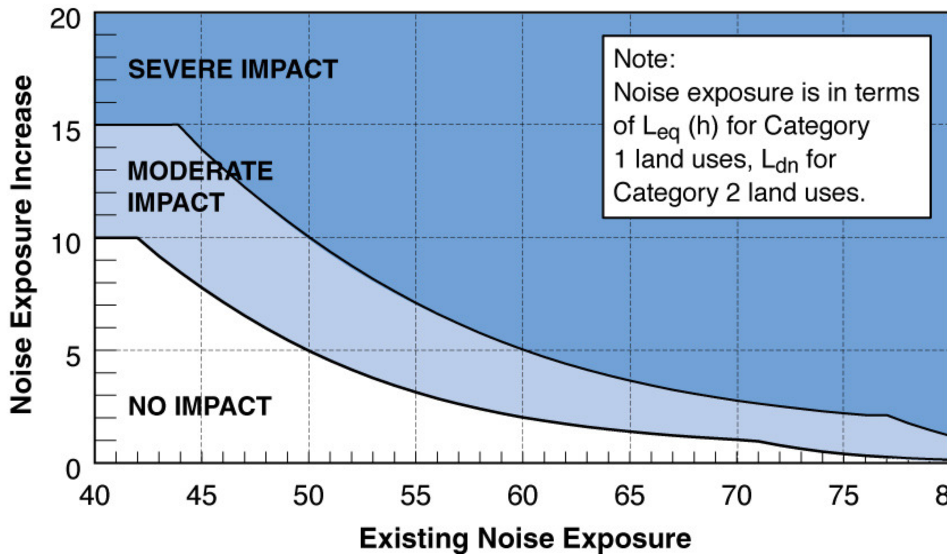
The FTA noise impact criteria are founded on well-documented research on community reaction to noise and are based on change in noise exposure using a sliding scale. At locations with higher levels of existing noise, smaller increases in total noise exposure are allowed.

The Ldn is used to characterize noise exposure for residential areas (Category 2). For other noise sensitive land uses, such as parks and school buildings (Categories 1 and 3), the maximum 1-hour "equivalent" sound level (Leq) during the facility's operating period is used. Ldn and Leq are explained in Section 5.8, *Noise*.

There are two levels of impact included in the FTA criteria:

- **Severe Impact:** Project-generated noise in the severe impact range can be expected to cause a large percentage of people to be highly annoyed by the new noise and represents the most compelling need for mitigation. Noise mitigation would normally be specified for severe impact areas unless there are truly extenuating circumstances that prevent it.
- **Moderate Impact:** In this range of noise impact, the change in the cumulative noise level is noticeable to most people but could not be sufficient to cause strong, adverse reactions from the community. Other project-specific factors must be considered to determine the magnitude of the impact and the need for mitigation. These factors include the existing noise level, the predicted level of increase over existing noise levels, the types and numbers of noise-sensitive land uses affected, the noise sensitivity of the properties, the effectiveness of the mitigation measures, community views and the cost of mitigating noise to more acceptable levels.

**Figure 6.7-7 Increase in Cumulative Noise Levels Allowed by FTA Criteria**




The FTA noise impact criteria are shown in graphical form in Figure 6.7-7. Along the horizontal axis of the graph is the existing noise exposure and the vertical axis shows the increase in future noise exposure due to the combination of the existing noise exposure and the additional noise exposure caused by the transit project. Figure 6.7-7 shows the noise impact criteria for Category 1 and 2 land uses. Because the Proposed Action includes modifications to existing noise sources, such as moving the existing commuter rail lines, it is not possible to define project noise separately from existing noise and, therefore, noise impact is assessed according to the increase in future noise exposure.

## Noise Projections

Future noise sources associated with the Proposed Action include MBTA Green Line operations, MBTA commuter rail operations, Amtrak and freight train operations, and noise associated with the maintenance and storage facility. Future noise from the commuter rail, Amtrak and freight trains is projected based on the existing noise measurements. Noise levels are dominated by commuter rail noise adjusted for future changes to the alignment such as shifting the tracks. The contribution to future noise levels from the proposed Green Line trains has been modeled based on methods outlined in the FTA guidance manual.

Maintenance and storage facility noise sources include train movements in and out of the yards, special trackwork (crossovers or turnouts), potential wheel squeal on tight radius curves, stationary cars in the yards operating with auxiliary equipment on, a traction power substation, and private automobiles in the employee parking lot.

Train movements in and out of the yards are non-revenue operations between the proposed yards to and from the closest stations (Union Station, Lechmere Station and Washington Street Station). These "pull in" and "pull out" movements are required to bring trains into or to take trains out of service for maintenance or at the end of the service day. These movements are in addition to the standard revenue service train operations.

Maintenance lead tracks and yard tracks often include special trackwork (crossovers or turnouts) or tight-radius curves which can increase noise levels associated with train movements into and out of the yards. Special trackwork introduces gaps into the rail running surface that would increase noise levels from the train as the wheels impact these gaps. Tight-radius curves, typically 400-foot radius or less, can cause wheel squeal, which is a high-frequency tonal noise. Another noteworthy noise source is stationary cars in the storage yards operating with auxiliary equipment on. Cars are typically operated under this condition in the early morning to heat or cool the interior and prepare the trains for revenue service as well as at other times during the day when cars are in the yards but would be required to return to service. The contribution of noise from such operation of cars in the storage yards is generally not as high as the train movements unless receptors are much closer to the storage yards than the mainline tracks.

Maintenance operations within the building such as wheel truing, using pneumatic tools and the car wash are not expected to be major noise sources as the building would substantially shield these activities. The HVAC system for the maintenance building is also not expected to be a major noise source. Unlike maintenance buildings for diesel-electric locomotives which require more substantial HVAC systems to handle the train exhaust, this building would only require normal levels of airflow for the electric Green Line vehicles.

Principal assumptions used in the analysis are provided in Appendix F, *Noise and Vibration Technical Report*. Future noise levels from the proposed Green Line trains are based on reference noise levels, site-specific conditions such as the terrain, intervening objects such as building rows, and operational plans including train consist (the number of cars), speed, and headways.

### 6.7.2 Noise Impacts

Extending the Green Line would add a new noise source to the environment along the proposed corridor. While there is existing noise exposure from sources such as commuter trains and automobiles, introducing an additional noise source and relocating the commuter rail lines have the potential to increase noise at some noise-sensitive receptors. The Proposed Action involves relocating the commuter rail lines to the east along some portions of the corridor and introducing the Green Line tracks on the west side of the corridor.

The potential noise impact has been assessed for the Proposed Action. Noise level projections for sensitive receptors that would be exposed to noise impact prior to any mitigation measures are shown in Table 6.7-1. This table lists the noise-sensitive receptor location, side of tracks, distances to the future commuter line and Green Line near track centerlines, the existing noise levels estimated at each location, moderate and severe noise impact criteria, the future projected noise level, increase in future noise level over the existing levels and the number of moderate and severe impacted buildings. Locations of potential noise impacts to sensitive receptors are shown in Figures 6.7-1 through 6.7-6.

Potential ground-borne noise impact has been assessed for sensitive locations, including the Tufts University Bacon Hall where there are no windows in the building facing the alignment and therefore airborne noise paths do not dominate, and at the Tufts University Curtis Hall which houses the WMFO radio station. Table 6.7-2 shows locations that would be exposed to ground-borne noise impact prior to mitigation. This table lists the receptor location, the side of the tracks, distances to the future commuter line and Green Line near track centerlines, the ground-borne noise impact criteria for each rail line, the future ground-borne noise levels from each rail line, the total number of impacted buildings, and the rail line that is causing impact.

All of the noise sensitive receptors listed in Table 6.7-1 are single-family and/or multi-family residential properties unless otherwise specified. Institutional land uses that would be exposed to airborne noise impact prior to mitigation include the Tufts Science and Technology Center, Outside the Line Artist Studio, and the Walnut Street Center (a nonprofit support center for adults with developmental disabilities) in Union Square. Trum Playground would also potentially be exposed to noise impact, prior to mitigation. Curtis Hall at Tufts University (WMFO radio station) and Bacon Hall at Tufts University (a building that has no windows facing track) would potentially be exposed to ground-borne noise impact.

At locations where there is no existing train activity (between Lechmere Station and Fitchburg Street), the future increase in noise levels due to the Proposed Action would be higher because existing noise levels are lower than where trains currently operate. In particular, future noise levels for the Glass Factory Condominiums, Hampton Inn Hotel, future building at 22 Water Street, and the northeast façade of the Brickbottom Artists Building are projected to be seven to 22 decibels higher due to the relatively quiet existing conditions. Tracks in the vicinity of Brickbottom Artists Building have been moved farther away from the northeast building façade in order to minimize noise impacts in this area.

Since existing noise levels are relatively high at locations along the existing commuter rail line, even small increases in future noise levels are considered to have the potential for moderate or severe noise impact. Potential noise impacts on the east side of the Medford Branch alignment along the existing MBTA Lowell Line are due primarily to the shifting of the commuter rail line closer to these sensitive properties. Future noise levels on the east side of the alignment would typically increase only one to three decibels prior to mitigation.

Potential noise impacts on the west side of the Medford Branch alignment are due primarily to the proximity of noise-sensitive receptors to the Green Line trains. At close distances (within approximately 50 feet) the contribution of noise from Green Line trains is more than from commuter trains. Future noise levels on the west side are projected to generally increase one to two decibels at most locations. At a few specific locations, such as the Walnut Street Center and residences on the east side of the alignment between Broadway and Harvard Street, the future increase in noise levels is higher (five to 10 decibels) due to the close proximity to the proposed Green Line trains and/or the introduction of new special trackwork such as the relocation of the commuter track interlocking.

Noise projections include contributions from the proposed maintenance and storage facility. While the facility contributes to the noise levels, the majority of the increase in noise levels from the Proposed Action would be due to mainline Green Line operations. In fact, at the Brickbottom Artists Building (northeast façade), where influence from the Option L maintenance and storage facility would be the greatest, noise from the mainline operations is projected to be 68.8 Ldn and noise from all of the maintenance and storage facility operations is projected to be 62.5 Ldn. The total future noise level which combines both of these project sources and existing noise sources is 70.7 Ldn. The future noise level would be Ldn 70.0 dBA without any contribution from the maintenance facility. The facility would only increase future noise levels by 0.7 decibels compared to the mainline operations alone. At other locations, the contribution of noise from the maintenance and storage facility would be even lower than at the northeast façade of the Brickbottom Artists Building.

## Table 6.7-1 Potential Noise Impacts Prior to Mitigation

| Noise Sensitive Receptor Location | Side of Tracks | Distance to Near Track (feet) Comm. Line | Green Line | Existing Noise Level (Ldn) | Impact Criteria Mod. | Sev. | Future Noise Level (Ldn) | Increase | Total Number of Impacts (buildings) Mod. | Sev. |
|---|---|---|---|---|---|---|---|---|---|---|
| **Segment between Lechmere Station and Fitchburg Mainline** | | | | | | | | | | |
| Archstone-Smith Phase II Development Building East of East Street (proposed) | East | n/a | 15 [1] | 69.2 | 70.3 | 72.1 | 76.1 | 6.9 | 0 | 1 |
| NorthPoint (Tango and Sierra) | East | n/a | 109 | 61.0 | 62.8 | 65.6 | 63.8 | 2.8 | 2 | 0 |
| Glass Factory Condominiums | West | n/a | 43 | 57.6 | 60.0 | 63.5 | 70.5 [2] | 12.9 | 0 | 1 |
| Hampton Inn Hotel | West | n/a | 41 | 57.6 | 60.0 | 63.5 | 71.2 [2] | 13.6 | 0 | 1 |
| 22 Water Street (proposed) | East | n/a | 60 [1] | 57.6 | 60.0 | 63.5 | 78.9 [2,6] | 22.3 | 0 | 1 |
| Brickbottom Artists Building (northeast façade) | West | n/a | 33 | 63.8 | 65.3 | 67.7 | 70.7 [2] | 6.9 | 0 | 1 |
| Brickbottom Artists Building (south façade) | North | 93 | 24 | 68.8 | 69.8 | 71.7 | 78.3 [2,6] | 9.5 | 0 | -- [3] |
| **Totals between Lechmere Station and MBTA Fitchburg Commuter Rail Line** | | | | | | | | | **2** | **5** |
| **Segment between MBTA Fitchburg Commuter Rail Line and Medford** | | | | | | | | | | |
| Alston Street near Cross Street | West | 59 | 25 | 74.4 | 74.8 | 76.6 | 76.1 | 1.7 | 4 | 0 |
| Avon Place and Auburn Ave near McGrath Highway | East | 33 | 61 | 77.2 | 77.4 | 79.2 | 77.6 | 0.4 | 11 | 0 |
| Gilman Street and Aldrich Street | East | 32 | 60 | 71.9 | 72.6 | 74.3 | 73.0 | 1.1 | 14 | 0 |
| Pearl Street near Medford Street | East | 29 | 57 | 71.8 | 72.5 | 74.2 | 73.1 | 1.3 | 1 | 0 |
| Richdale Avenue | East | 39 | 67 | 75.5 | 75.8 | 77.6 | 77.4 | 1.9 | 19 | 0 |
| Sycamore Street near Richdale Avenue [8] | East | 65 | 93 | 71.2 | 72.1 | 73.8 | 72.9 | 1.7 | 1 | 0 |
| Vernon Street between Trull Street and Partridge Avenue | East | 97 | 120 | 68.4 | 69.4 | 71.3 | 69.6 | 1.2 | 6 | 0 |
| Vernon Street and Lowell Street | East | 29 | 57 | 74.3 | 74.7 | 76.5 | 76.2 | 1.9 | 4 | 0 |
| Nashua Street, Henderson Street and Hinckley Street | East | 37 | 65 | 78.0 | 78.2 | 79.8 | 80.4 | 2.4 | 0 | 4 |
| Hinckley Street and Berwick Street | East | 37 | 65 | 78.0 | 78.2 | 79.8 | 78.9 [8] | 0.9 | 4 | 0 |
| Cedar Street | East | 22 | 50 | 73.0 | 73.6 | 75.4 | 76.5 | 3.5 | 0 | 1 |
| Wilson Avenue and Cedar Street | East | 71 | 99 | 67.9 | 69.1 | 71.0 | 69.8 | 1.9 | 3 | 0 |
| Trum Playground [4] | East | 36 | 67 | 68.6 [4] | 71.4 [4] | 74.7 [4] | 72.0 [4] | 3.4 | 17 [5] | 0 |
| Boston Avenue between Cedar Street and Broadway | West | 59 | 28 | 73.0 | 73.6 | 75.4 | 73.8 | 0.8 | 19 | 0 |
| Winchester Street between Granvile Avenue and Winchester Court (3rd Row) | East | 104 | 132 | 65.9 | 67.1 | 69.3 | 70.1 [6] | 4.2 | 0 | 12 |
| Winchester Street between Morton Avenue and Granville Avenue (3rd Row) | East | 148 | 176 | 60.8 | 62.7 | 65.6 | 64.7 [6] | 3.9 | 4 | 0 |
| Boston Avenue (Powderhouse Condos) | West | 78 | 41 | 75.7 | 76.0 | 77.8 | 80.2 [7] | 4.5 | 0 | 1 |
| Tufts - Science and Technology Center and Outside the Lines Art Studio [4] | East | 27 | 55 | 77.0 [4] | 77.7 [4] | 81.5 [4] | 80.3 [4] | 3.3 | 2 | 0 |
| Burget Avenue near College Avenue | East | 29 | 73 | 72.2 | 74.2 | 77.5 | 74.9 | 2.7 | 3 | 0 |
| Burget Avenue | East | 47 | 75 | 71.2 | 72.1 | 73.8 | 72.4 | 1.2 | 11 | 0 |
| **Totals between MBTA Fitchburg Commuter Rail Line and Medford** | | | | | | | | | **107** | **32** |

## Table 6.7-1 Potential Noise Impacts Prior to Mitigation (continued)

| Noise Sensitive Receptor Location | Side of Tracks | Distance to Near Track (feet) Comm. Line | Distance to Near Track (feet) Green Line | Existing Noise Level (Ldn) | Impact Criteria Mod. | Impact Criteria Sev. | Future Noise Level (Ldn) | Increase | Total Number of Impacts (buildings) Mod. | Total Number of Impacts (buildings) Sev. |
|---|---|---|---|---|---|---|---|---|---|---|
| **Segment between MBTA Fitchburg Commuter Rail Line and Medford** | | | | | | | | | | |
| Newbern Avenue | East | 33 | 61 | 76.7 | 76.9 | 78.7 | 79.4 | 2.7 | 0 | 2 |
| Morton Avenue, Granville Avenue, Winchester Place, Winchester Court (1st row) | East | 29 | 57 | 75.9 | 76.1 | 77.9 | 85.4[6] | 9.5 | 0 | 6 |
| Morton Avenue and Granville Avenue, (2nd row) | East | 58 | 86 | 69.0 | 70.0 | 71.8 | 76.8[6] | 7.8 | 0 | 6 |
| **Segment between McGrath Highway and Prospect Street (Union Square)** | | | | | | | | | | |
| #40 & #41 Horace Street | South | 21 | 35 | 65.2 | 66.6 | 68.8 | 70.1 | 4.9 | 0 | 2 |
| #39 Horace Street (2nd Row) | South | 43 | 57 | 61.0 | 62.8 | 65.6 | 64.8 | 3.8 | 1 | 0 |
| Walnut Street Ceneter[4] | North | 58 | 30 | 63.3[4] | 67.1[4] | 71.0[4] | 72.2[4,5] | 8.9 | 0 | 1 |
| Charlestown Street | North | 113 | 85 | 61.0 | 62.8 | 65.6 | 66.5-5 | 5.5 | 0 | 1 |
| Charlestown Street | North | 138 | 110 | 61.0 | 62.8 | 65.6 | 64.8[5] | 3.8 | 1 | 0 |
| **Totals between McGrath Highway and Prospect Street (Union Square)** | | | | | | | | | **2** | **4** |
| **Total Noise Impacts for Category 2 Land Use (Residential)** | | | | | | | | | **108** | **40** |
| **Total Noise Impacts for Category 3 Land Use (Institutional)** | | | | | | | | | **2** | **1** |
| **Total Nosie Impacts for Category 3 Land Use (Park)** | | | | | | | | | **1** | **0** |

Source: Harris Miller Miller and Hanson, Inc. *MBTA Green Line Extension Noise and Vibration Technical Report, Environmental Assessment*, August 2011.

1 Distance to alignment estimated for future proposed property

2 Projected noise levels include following contributions from noise generated due to the maintenance facility (Option L).

a. Glass Factory Condominiums, 57.3
b. Hampton Inn Hotel, 57.8
c. 22 Water Street, 59.3
d. Brickbottom Artists Buildings (northeast façade), 62.5
e. Brickbottom Artists Buildings (southeast façade), 66.6

3 Impact for Brickbottom Artists Building is counted under listing for Brickbottom Artist Building (northeast façade)

4 Peak-transit hour Leq used for institutional land use.

5 Noise impact at Trum Playground does not include a building structure.

6 Future noise projections include contributions from special trackwork.

7 Future noise projections include elimination of special trackwork from current commuter rail tracks.

8 Susan Russell House (#58 Sycamore St) is a National Register-listed historic property.

### Table 6.7-2 Potential Ground-Borne Noise Impacts Prior to Mitigation

| Noise Sensitive Receptor Location | Side of Tracks | Distance to Near Track (feet) | | Ground-Borne Noise Impact Criteria (dBA) | | Future Ground-Borne Noise Levels | | Total Number of Impacts (Buildings) | Rail Line Causing Impact |
|---|---|---|---|---|---|---|---|---|---|
| | | Comm. Line | Green Line | Comm. Line | Green Line | Comm. Line | Green Line | | |
| **Segment between Fitchburg Mainline and Medford** | | | | | | | | | |
| Tufts University – Bacon Hall[1] | West | 50 | 17 | 43 | 40 | 40 | 50 | 1 | Green |
| Tufts University – Curtis Hall (WMFO Radio)[2] | West | 80 | 40 | 25 | 25 | 41 | 41 | 1 | Both |
| **Total Ground-Borne Noise Impacts for Category 3 Land Use (Institutional)** | | | | | | | | **2** | |

Source: Harris Miller Miller and Hanson, Inc. *MBTA Green Line Extension Noise and Vibration Technical Report, Environmental Assessment*, August 2011.
1 Potential ground-borne noise impact has been identified for Bacon Hall as it has no windows facing the tracks.
2 Sensitive use in Curtis Hall includes WMFO radio station which has been assessed as a recording studio.

Table 6.7-3 provides a summary of noise sensitive receptors that are projected to be exposed to moderate and severe noise impact. Without mitigation, 152 noise-sensitive receptors would be exposed to impact including 108 moderate impacts and 40 severe impacts at single-family and multi-family residential buildings, moderate impact at Tufts University Science and Technology Center and Outside the Line Artist's Studio, moderate impact at Trum Playground, severe noise impact at the Walnut Street Center near Union Square, and ground-borne noise impact at Tufts Bacon Hall and Tufts Curtis Hall.

### Table 6.7-3 Summary of Potential Noise Impacts

| Residential Buildings Impacted | | Institutional Buildings and Parks Impacted | | |
|---|---|---|---|---|
| Moderate | Severe | Moderate | Severe | Ground-Borne Noise |
| 108 | 40 | 3[1] | 1 | 2[2] |

Source: Harris Miller Miller and Hanson, Inc. *MBTA Green Line Extension Noise and Vibration Technical Report, Environmental Assessment,* August 2011.
1 Moderate impacts include Tufts University Science and Technology Center, Outside the Line Artist's Studio and Trum Playground.
2 Ground-borne noise impacts include Tufts Bacon Hall and Tufts Curtis Hall.

## Temporary Construction Noise Impacts

The construction noise criteria applicable to the Proposed Action are based on the Central Artery/Tunnel Noise Control Specification 721.560. This detailed construction noise specification is consistent with the City of Cambridge Noise Ordinance (Ord. 1326, Chapter 8.16.070, adopted May 18, 2009), the City of Somerville Noise Ordinance (No. 2000-11, §§ I—VII, IX, adopted November 22, 2000) and the City of Medford Noise Ordinance (Revised Ordinances Chapter 38, Article II, Section 38-34). This specification establishes noise criteria limits according to time of day and type of sensitive land use, defining allowable limits for the maximum noise emissions of specific equipment, requirements for a noise monitoring plan to be prepared prior to construction, noise monitoring equipment, noise reduction measures, and reporting requirements. Unlike the assessment of long-term noise impact from the train operations, potential short-term noise impact from construction activities is assessed at commercial and industrial land uses.

Temporary noise impacts could result from these construction activities. Such impacts could occur in residential areas and at other noise-sensitive land use located within several hundred feet of the alignment. The potential for noise impact would be greatest at locations near pile driving operations for bridges and other structures, and at locations close to any nighttime construction activities. Construction noise mitigation measures are discussed in Section 7.3.4, *Noise*.

### 6.7.3 Summary

Prior to mitigation, 152 noise-sensitive receptors would be exposed to impact including 108 moderate impacts and 40 severe impacts at single-family and multi-family residential buildings, moderate impact at Tufts University Science and Technology Center and Outside the Line Artist's Studio, moderate impact at Trum Playground, severe noise impact at the Walnut Street Center near Union Square, and ground-borne noise impact at Tufts Bacon Hall and Tufts Curtis Hall. Information on the proposed noise mitigation is provided in Section 7.3.4, *Noise*.

## 6.8 Vibration

This section provides the impacts analysis for vibration. Appendix F, *Noise and Vibration Technical Report,* provides the full Noise and Vibration Technical Report.[20] Figure 6.7-1 shows the measurement sites and proposed vibration mitigation locations. Figures 6.8-1 through 6.8-5 show those locations that would be impacted by vibration, as well as the proposed mitigation measures described in Chapter 7, *Mitigation Commitments,* of this EA.

### 6.8.1 Vibration Impact Methodology

The vibration impact assessment methodology includes conducting reference vibration measurements of MBTA commuter rail trains and Green Line trains, conducting measurements of the vibration propagation characteristics of the soil along the proposed corridor, projecting future vibration levels from the project, assessing potential impacts, and determining the need, feasibility and reasonableness of mitigation recommendations. Future vibration levels from the project would be generated from the proposed Green Line trains and existing commuter rail trains and includes modifications to the commuter rail lines.

20 Harris Miller Miller and Hanson, Inc. *MBTA Green Line Extension Noise and Vibration Technical Report, Environmental Assessment*, August 2011.

## Vibration Impact Criteria

The FTA vibration impact criteria are based on land use and train frequency, as shown in Table 6.8-1. There are some buildings, such as concert halls, recording studios and theaters that can be very sensitive to vibration but do not fit into any of the three categories listed in Table 6.8-1. Due to the sensitivity of these buildings, they usually warrant special attention during the assessment of a transit project. Table 6.8-2 gives criteria for acceptable levels of ground-borne vibration for various types of special buildings.

It should also be noted that there are separate FTA criteria for ground-borne noise, as discussed in the previous section, the "rumble" that can be radiated from the motion of room surfaces in buildings due to ground-borne vibration. Such criteria are particularly important for underground transit operations. However, because airborne noise tends to mask ground-borne noise from above ground (*i.e.*, at-grade or elevated) rail systems, ground-borne noise levels are generally only assessed in buildings without airborne noise paths.

In addition to the criteria provided in Tables 6.8-1 and 6.8-2 for general assessment purposes, the FTA has established criteria in terms of one-third octave band frequency spectra for use in detailed analyses. Table 6.8-3 and Figure 6.8-6 show the vibration criteria and a description of their use.

### Table 6.8-1 FTA Ground-Borne Noise and Vibration Impact Criteria

| | Ground-Borne Vibration Impact Levels (VdB re 1 micro-inch/sec) | | | Ground-Borne Noise Impact Levels (dBA re 20 micro-pascals) | | |
|---|---|---|---|---|---|---|
| **Land Use Category** | **Frequent Events[1]** | **Occasional Events[2]** | **Infrequent Events[3]** | **Frequent Events[1]** | **Occasional Events[2]** | **Infrequent Events[3]** |
| Category 1: Buildings where low ambient vibration is essential for interior operations. | 65 VdB[4] | 65 VdB[4] | 65 VdB[4] | n/a[5] | n/a[5] | n/a[5] |
| Category 2: Residences and buildings where people normally sleep. | 72 VdB | 75 VdB | 80 VdB | 35 dBA | 38 dBA | 43 dBA |
| Category 3: Institutional land uses with primarily daytime use. | 75 VdB | 78 VdB | 83 VdB | 40 dBA | 43 dBA | 48 dBA |

Source: United States Department of Transportation, Federal Transit Administration *Guidance Manual. Transit Noise and Vibration Impact Assessment*, Report FTA-VA-90-1003-06, May 2006.

1 "Frequent Events" is defined as more than 70 vibration events per day. Most rapid transit projects fall into this category.

2 "Occasional Events" is defined as between 30 and 70 vibration events of the same kind per day. Most commuter rail trunk lines have this many operations.

3 "Infrequent Events" is defined as fewer than 30 vibration events of the same kind per day. This category includes most commuter rail branch lines.

4 This criterion limit is based on levels that are acceptable for most moderately sensitive equipment such as optical microscopes. Vibration sensitive manufacturing or research would require detailed evaluation to define the acceptable vibration levels. Ensuring lower vibration levels in a building often requires special design of the HVAC systems and stiffened floors.

5 Vibration-sensitive equipment is generally not sensitive to ground-borne noise.

### Table 6.8-2 FTA Ground-Borne Noise and Vibration Impact Criteria for Special Buildings

| Type of Building or Room[3] | Ground-Borne Vibration Impact Levels (VdB re 1 micro-inch/sec)[1] Frequent Events[4] | Ground-Borne Vibration Impact Levels (VdB re 1 micro-inch/sec)[1] Occasional or Infrequent Events[5] | Ground-Borne Noise Impact Levels (dBA re 20 micro-pascals)[2] Frequent Events[4] | Ground-Borne Noise Impact Levels (dBA re 20 micro-pascals)[2] Occasional or Infrequent Events[5] |
|---|---|---|---|---|
| Concert Halls | 65 VdB | 65 VdB | 25 dBA | 25 dBA |
| TV Studios | 65 VdB | 65 VdB | 25 dBA | 25 dBA |
| Recording Studios | 65 VdB | 65 VdB | 25 dBA | 25 dBA |
| Auditoriums | 72 VdB | 80 VdB | 30 dBA | 38 dBA |
| Theatres | 72 VdB | 80 VdB | 35 dBA | 43 dBA |

Source: United States Department of Transportation, Federal Transit Administration *Guidance Manual. Transit Noise and Vibration Impact Assessment*, Report FTA-VA-90-1003-06, May 2006.

1 "Ground-borne vibration" is the oscillatory motion of the ground about an equilibrium position. Ground-born vibration levels are reported in terms of velocity vibration decibels (VdB) with a reference level of 1 micro-inch per second.

2 "Ground-borne noise" is produced when ground-borne vibrations propagate into a room and radiate noise from the motion of the surfaces. Ground-borne noise levels are reported in terms of A-weighted sound level decibels (dBA) with a reference level of 20 micro-pascals.

3 If the building would rarely be occupied when the trains are operating, there is no need to consider impact. As an example consider locating a commuter rail line next to a concert hall. If no commuter trains would operate after 7 pm, it should be rare that the trains interfere with the use of the hall.

4 "Frequent Events" is defined as more than 70 vibration events per day. Most rapid transit projects fall into this category.

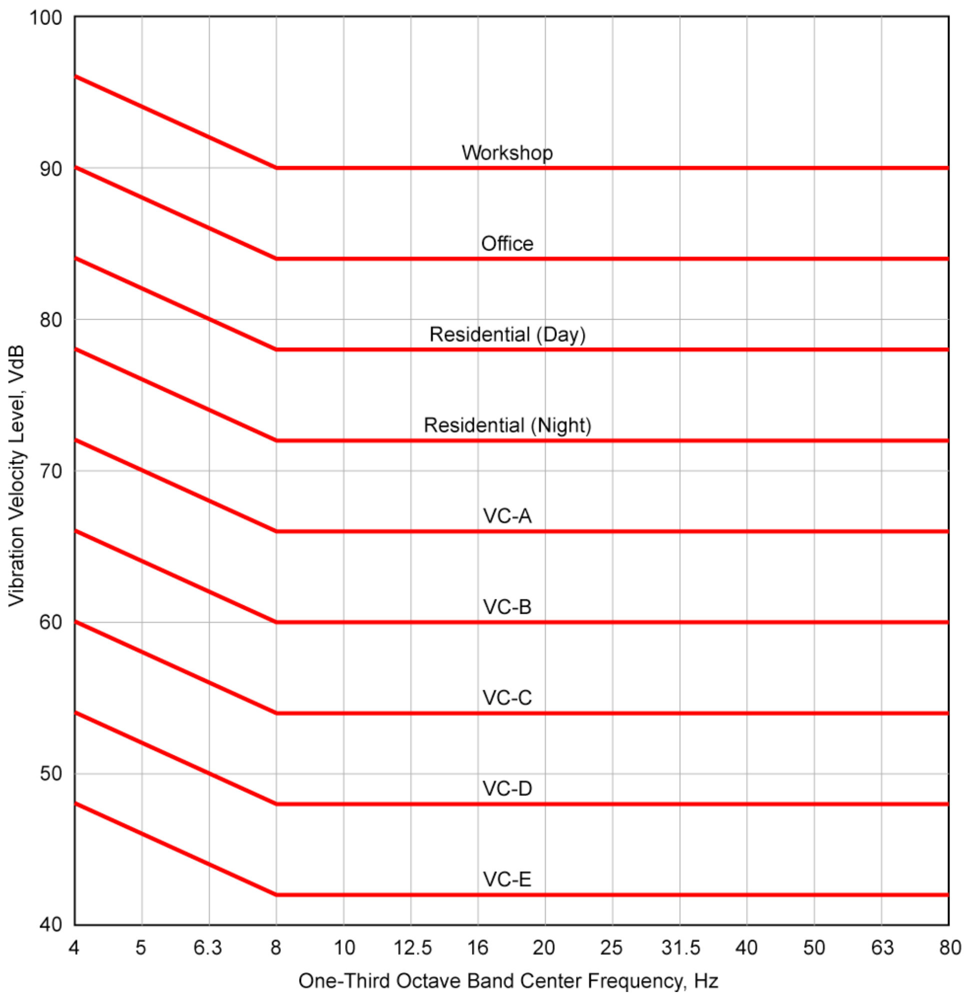
5 "Occasional or Infrequent Events" is defined as fewer than 70 vibration events per day. This category includes most commuter rail lines.

### Table 6.8-3 Vibration Criteria for Detailed Analysis by Building Use

| Criterion Curve | Maximum Vibration Level (VdB re 1 micro-inch/sec) | Description of Use |
|---|---|---|
| Workshop | 90 | Distinctly feelable vibration. Appropriate to workshops and non-sensitive areas |
| Office | 84 | Feelable vibration. Appropriate to offices and non-sensitive areas |
| Residential Day | 78 | Barely feelable vibration. Adequate for computer equipment and low-power optical microscopes (up to 20X) |
| Residential Night, Operating Rooms | 72 | Vibration not feelable, but ground-borne noise could be audible inside quiet rooms. Suitable for medium-power optical microscopes (100X) and other equipment of low sensitivity |
| VC-A | 66 | Adequate for medium- to high-power optical microscopes (400X), microbalances, optical balances, and similar specialized equipment |
| VC-B | 60 | Adequate for high-power optical microscopes (1000X), inspection and lithography equipment to 3 micron line widths |
| VC-C | 54 | Appropriate for most lithography and inspection equipment to 1 micron detail size |
| VC-D | 48 | Suitable in most instances for the most demanding equipment, including electron microscopes operating to the limits of their capability |
| VC-E | 42 | The most demanding criterion for extremely vibration-sensitive equipment |

Source: United States Department of Transportation, Federal Transit Administration *Guidance Manual. Transit Noise and Vibration Impact Assessment*, Report FTA-VA-90-1003-06, May 2006.

**Figure 6.8-6 Criteria for Detailed Vibration Analysis**




Source: United States Department of Transportation, Federal Transit Administration *Guidance Manual. Transit Noise and Vibration Impact Assessment*, Report FTA-VA-90-1003-06, May 2006.

For residential buildings with nighttime occupancy, the applicable criterion for vibrations generated by commuter trains (occasional events) is a maximum velocity level of 75 VdB, measured in any one-third octave band over the frequency range from 4 Hz to 80 Hz. For residential buildings, the applicable criterion for vibrations generated from Green Line trains (frequent events) is 72 VdB. For institutional buildings such as schools, libraries and churches, the applicable criterion for vibration generated from commuter trains is 78 VdB and the criterion for vibration generated from Green Line trains is 75 VdB.

For buildings with vibration-sensitive equipment, the applicable criterion for either Green Line or commuter trains is a maximum vibration level of 65 VdB. The applicable ground-borne noise criterion for the WMFO radio station (recording studio) in Curtis Hall at Tufts University is 25 dBA for Green Line or commuter trains. For noise-sensitive spaces inside Bacon Hall, which has no windows facing the tracks, the ground-borne noise criteria are 40 dBA for Green Line trains and 43 dBA for commuter trains, as described in the previous section.

In addition to ground-borne vibration criteria for humans in residential, institutional and special buildings, and vibration-sensitive equipment, there are ground-borne vibration criteria for potential damage to structures. The limits of vibration that structures can withstand are substantially higher than those for humans and for sensitive equipment. Table 6.8-4 presents criteria for assessing the potential for vibration damage to structures based on the type of building construction. This table includes rms vibration levels in VdB reference to one micro-inch per second and peak-particle velocity levels in inches per second. A crest factor of four, representing a difference of 12 decibels between peak and rms, is used in this table. It should be noted that these criteria are more conservative than other standards such as the U.S. Bureau of Mines frequency-dependent vibration criteria which is equivalent to approximately 114 VdB at 40 Hz and above.

### Table 6.8-4 Vibration Criteria for Detailed Analysis by Building Category

| Building Category | Ground-Borne Vibration Velocity (VdB) and Peak-Particle Velocity Equivalent (in/s) |
|---|---|
| Reinforced-concrete steel or timber | 102 VdB (0.5 in/s) |
| Engineered concrete and masonry | 98 VdB (0.3 in/s) |
| Non-engineered timber and masonry buildings | 94 VdB (0.2 in/s) |
| Buildings extremely susceptible to vibration damage | 90 VdB (0.12 in/s) |

Source: United States Department of Transportation, Federal Transit Administration *Guidance Manual. Transit Noise and Vibration Impact Assessment*, Report FTA-VA-90-1003-06, May 2006.

## Vibration Projections

Similar to noise, vibration level projections are based on planned operations of existing commuter trains and proposed Green Line trains, measured reference levels of existing commuter trains and Green Line trains, measurements of the vibration propagation characteristics of the soil and prediction modeling from the FTA guidance manual. The principal assumptions used in this analysis are similar to the noise projections and are provided in Appendix F, *Noise and Vibration Technical Report*.

Vibration levels are projected at sensitive receptors based on the detailed vibration analysis methodology in the FTA guidance manual. Future vibration levels are projected based on reference measurements of the commuter and Green Line trains and measurements of the vibration propagation characteristics of the soil.

### 6.8.2 Vibration Impacts

The Green Line Extension project would add a new vibration source to the environment along the proposed corridor. While there is existing vibration exposure from sources such as commuter trains, Green Line trains near the existing Lechmere Station, and automobiles, introducing an additional vibration source and relocating the commuter rail lines have the potential to increase future vibration at some sensitive receptors. The Proposed Action involves relocating the commuter rail lines to the east along some portions of the corridor and adding the proposed Green Line tracks on the west side of the corridor.

Potential vibration impact has been assessed for the Proposed Action. Vibration level projections for sensitive receptors that would be exposed to vibration impact without any mitigation measures are shown in Table 6.8-5. This table shows the vibration-sensitive receptor location, side of tracks, the distances to the near-track centerline and vibration projections for the existing commuter line, future commuter line and Green Line, the number of impacted buildings, and the railway causing impact. Potential vibration impact locations are shown in Figures 6.8-1 through 6.8-5.

Vibration impact from the commuter trains generally occurs within 60 feet of the future commuter rail near-track centerline and within 40 feet of the proposed Green Line near-track centerline. Most receptors projected to be exposed to vibration impact from commuter train activity are located on the east side of the MBTA Lowell Line or the south side of the MBTA Fitchburg Line where the proposed commuter rail near track is planned to shift closer to receptors. Most receptors projected to be exposed to vibration impact from Green Line train activity are located on the west side of the MBTA Lowell Line.

All of the receptors listed in Table 6.8-5 are single-family or multi-family residential properties unless otherwise noted. Institutional land uses that are projected to be exposed to vibration impact include the Science and Technology Center, Bacon Hall, Bray Labs, and Curtis Hall at Tufts University and Outside the Line Artist Studio. Vibration impact at Tufts Science and Technology Center and Bacon Hall includes potential effect to humans and vibration-sensitive equipment. Vibration impact at Bray Labs is due only to potential effect to vibration-sensitive equipment and impact at Curtis Hall is due only to potential effect to the radio station. At five receptors on Morton Avenue, Granville Avenue, Winchester Place, and Winchester Street, there is the potential for structural damage due primarily to the introduction of special trackwork (commuter track interlocking) and the proximity of commuter trains. The potential for vibration impact at the future proposed Tufts Integrated Research Laboratory at 550 – 574 Boston Avenue depends on the construction of the building and its setback from the rail corridor. There would be no potential for impact to humans (annoyance) but there would be a potential for impact to vibration-sensitive equipment. Since this building would be on the west side of the alignment and the commuter lines would be shifted further away, vibration impact would not be expected unless the building was constructed very close to the near-track of the proposed Green Line.

## Table 6.8-5 Potential Vibration Impacts at Sensitive Receptors Prior to Mitigation

| | | Distance to Near Track (feet) | | | Maximum Vibration Velocity Level in any 1/3-Octave band from 4 to 80 Hz (VdB re: 1 -in./sec) | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Vibration Sensitive Receptor Location | Side of Tracks | Existing Comm. Line | Future Comm. Line | Green Line | Existing Comm. Line | Future Comm. Line | Green Line | Total Number of Impacted Buildings | Rail Line Causing Impact |
| **Segment between Lechmere Station and Medford** | | | | | | | | | |
| Brickbottom Artists Building (South Façade) | North | 81 | 93 | 24 | 57 | 55 | 80 | 1 | Green |
| Alston Street near Cross Street | West | 59 | 59 | 25 | 77 | 77 | 88 | 4 | Both |
| Avon Place | East | 33 | 33 | 61 | 91 | 91 | 69 | 4 | Comm. |
| Auburn Avenue near McGrath Highway | East | 46 | 46 | 74 | 83 | 83 | 65 | 7 | Comm. |
| Aldrich Street | East | 43 | 43 | 71 | 89[1] | 84 | 65 | 2 | Comm. |
| Gilman Street near Aldrich Street | East | 58 | 58 | 86 | 77 | 77 | 61 | 3 | Comm. |
| Gilman Street near Walnut Street | East | 32 | 32 | 60 | 92 | 92 | 69 | 9 | Comm. |
| Medford Street west of Walnut Street | West | 77 | 79 | 37 | 67 | 66 | 74 | 4 | Green |
| Pearl Street near Medford Street | East | 32 | 29 | 57 | 82 | 85 | 54 | 1 | Comm. |
| Richdale Avenue | East | 59 | 45 | 73 | 69 | 78 | 61 | 22 | Comm. |
| Vernon Street near Lowell Street | East | 39 | 29 | 57 | 78 | 88 | 58 | 3 | Comm. |
| Lowell Street near Vernon Street | East | 57 | 42 | 70 | 71 | 81 | 58 | 1 | Comm. |
| Nashua Street, Henderson Street, Hinckley Street | East | 55 | 37 | 65 | 81[1] | 85 | 58 | 4 | Comm. |
| Hinckley Street | East | 55 | 37 | 65 | 81[1] | 85 | 68[1] | 2 | Comm. |
| Murdock Street | West | 39 | 57 | 29 | 78 | 65 | 83 | 1 | Green |
| Murdock Street near Cedar Street | West | 43 | 61 | 33 | 80 | 68 | 79 | 1 | Green |
| Cedar Street | East | 40 | 22 | 50 | 78 | 90 | 66 | 1 | Comm. |
| Newbern Avenue (Multi-family apartments) | East | 51 | 33 | 61 | 68 | 77 | 55 | 1 | Comm. |
| #86 Morton Avenue (Industrial) | East | 28 | 15 | 40 | 80 | 103[1,2] | 61 | n/a[3] | Comm. |
| #85 Morton Avenue | East | 33 | 15 | 43 | 83 | 109[1,2] | 65 | 1 | Comm. |
| #83 Morton Avenue | East | 75 | 60 | 88 | 65 | 79[1] | 50 | 1 | Comm. |
| #82 Morton Avenue | East | 78 | 63 | 91 | 66 | 80[1] | 50 | 1 | Comm. |
| #53 Granville Avenue | East | 40 | 22 | 50 | 78 | 100[1,2] | 62 | 1 | Comm. |
| #49 Granville Avenue | East | 85 | 67 | 95 | 64 | 78[1] | 49 | 1 | Comm. |
| #6 Winchester Place (front) | East | 60 | 42 | 70 | 70 | 87[1] | 55 | 1 | Comm. |
| #6 Winchester Place (rear) | East | 38 | 20 | 48 | 79 | 102[1,2] | 63 | 1 | Comm. |
| #7 Winchester Place | East | 53 | 35 | 63 | 73 | 91[1] | 57 | 1 | Comm. |

Source: Harris Miller Miller and Hanson, Inc. *MBTA Green Line Extension Noise and Vibration Technical Report,* August 2011.

1 Projected vibration levels include contribution from special trackwork

2 Vibration levels prior to mitigation are projected to exceed criterion for potential structural damage at 85 Morton Avenue, 86 Morton Avenue (commercial property), #53 Granville Avenue, #6 Winchester Place (rear building) and #15 Winchester Street.

3 Industrial properties are not considered sensitive to vibration for human annoyance per FTA land use categories; however, they are sensitive to potential structural damage.

4 Buildings contain vibration-sensitive equipment with ground-vibration impact criterion of 65 VdB.

5 Building contains a radio station with ground-borne-vibration impact criterion of 65 VdB.

**Table 6.8-5 Potential Vibration Impacts at Sensitive Receptors Prior to Mitigation (continued)**

| Vibration Sensitive Receptor Location | Side of Tracks | Distance to Near Track (feet) | | | Maximum Vibration Velocity Level in any 1/3-Octave band from 4 to 80 Hz (VdB re: 1 -in./sec) | | | Total Number of Impacted Buildings | Rail Line Causing Impact |
|---|---|---|---|---|---|---|---|---|---|
| | | Existing Comm. Line | Future Comm. Line | Green Line | Existing Comm. Line | Future Comm. Line | Green Line | | |
| **Segment between Lechmere Station and Medford (continued)** | | | | | | | | | |
| #8 Winchester Court | East | 63 | 45 | 73 | 69 | 86[1] | 54 | 1 | Comm. |
| #15 Winchester Street (Industrial) | East | 35 | 20 | 48 | 81 | 102[1,2] | 63 | n/a[3] | Comm. |
| Boston Avenue (Powderhouse Condominiums) | West | 56 | 72 | 32 | 72 | 76[1] | 71 | 1 | Comm. |
| Tufts - Science and Technology Center[4] | East | 45 | 27 | 55 | 68 | 79 | 56 | 1 | Comm. |
| Outside the Line Art Studio | East | 45 | 27 | 55 | 68 | 79 | 56 | 1 | Comm. |
| Tufts – Bacon Hall[4] | West | 29 | 50 | 17 | 73 | 62 | 76 | 1 | Green |
| Tufts – Bray Labs[4] | West | 46 | 68 | 35 | 67 | 60 | 65 | 1 | Green |
| Tufts – Curtis Hall[5] | West | 56 | 80 | 40 | 62 | 64[1] | 66[1] | 1 | Green |
| **Total between Lechmere Station and Medford** | | | | | | | | **86** | |
| **Segment between McGrath Hwy and Prospect Street on MBTA Fitchburg Commuter Rail Line (Union Square Branch)** | | | | | | | | | |
| #40 & #41 Horace Street | South | 35 | 21 | 35 | 80 | 92 | 81 | 2 | Both |
| **Total between McGrath Hwy and Prospect Street on MBTA Fitchburg Commuter Rail Line (Union Square Branch)** | | | | | | | | **2** | |
| **Total Vibration Impacts for Category 2 Land Use (Residential)** | | | | | | | | **83** | |
| **Total Vibration Impacts for Category 3 Land Use (Institutional)** | | | | | | | | **5** | |
| **Total Vibration Impacts for Potential Structural Damage [2]** | | | | | | | | **5** | |

Source: Harris Miller Miller and Hanson, Inc. *MBTA Green Line Extension Noise and Vibration Technical Report,* August 2011.

1 Projected vibration levels include contribution from special trackwork

2 Vibration levels prior to mitigation are projected to exceed criterion for potential structural damage at 85 Morton Avenue, 86 Morton Avenue (commercial property), #53 Granville Avenue, #6 Winchester Place (rear building) and #15 Winchester Street.

3 Industrial properties are not considered sensitive to vibration for human annoyance per FTA land use categories; however, they are sensitive to potential structural damage.

4 Buildings contain vibration-sensitive equipment with ground-vibration impact criterion of 65 VdB.

5 Building contains a radio station with ground-borne-vibration impact criterion of 65 VdB.

## Temporary Construction Vibration Impacts

Only in very rare instances do vibrations generated by transit operations pose any risk of damage to nearby structures. Typically, the potential risk of vibration causing damage to nearby structures is greatest from certain construction activities - clam shovel drops, impact pile driving, caisson drilling, loaded trucks, hoe rams, and jackhammers - at very close distances. Although construction vibrations are only temporary, it is still reasonable to assess the potential for human annoyance and building damage.

Potential damage to nearby structures would not occur beyond 18 feet from most construction equipment. Potential damage from impact pile driving could occur within 40 feet. The distance to potential human annoyance is less than 80 feet for a hoe ram, caisson drilling and loaded trucks, 43 feet from a jackhammer, 135 feet from a clam shovel drop and 291 feet from impact pile driving.

The distances to potential impact show that temporary vibration impacts along the proposed corridor could result from construction activities. During preliminary engineering, a detailed construction vibration analysis will be conducted based on specific construction equipment and methods anticipated and mitigation measures will be identified. The potential for impact depends on the contractor's specific construction equipment and methods used.

For at-grade track construction, structural damage to buildings is not anticipated from typical construction methods which include equipment such as backhoes, graders and tie inserters. For construction of retaining walls, certain construction methods such as sheet piling could cause impact to some buildings in close proximity prior to mitigation. Other retaining wall construction methods such as those that utilize drilling or construction of gravity retaining walls which primarily include excavation equipment have less potential for impact. Low-vibration retaining wall construction methods, such as those that use hydraulic push-in equipment, have the least potential for impact. The potential for vibration impact would be greatest at locations near pile driving and vibratory compactor operations. Construction vibration mitigation is discussed in Section 7.3.6, *Vibration*, of this EA.

### 6.8.3 Summary

Prior to mitigation, 88 vibration-sensitive buildings would potentially be exposed to impact due to the Proposed Action. This includes 83 single-family and multi-family residential buildings and five institutional buildings (Tufts Science and Technology Center, Tufts Bacon Hall, Tufts Bray Laboratory, Tufts Curtis Hall, and Outside the Line Artist's Studio). Information of the proposed vibration mitigation is provided in Section 7.3.6, *Vibration*. Table 6.8-6 presents a summary of vibration-sensitive receptors that would be exposed to vibration impact prior to mitigation.

**Table 6.8-6 Summary of Potential Vibration Impacts Prior to Mitigation**

| Residential Buildings Impacted | Institutional Buildings Impacted[1] |
|---|---|
| 83 | 5 |

Source: Harris Miller Miller and Hanson, Inc. *MBTA Green Line Extension Noise and Vibration Technical Report*, August 2011.
1 Institutional buildings include the Tufts Science and Technology Center, Tufts Bacon Hall, Tufts Bray Laboratory, Tufts Curtis Hall, and Outside the Lines Studio.

## 6.9 Stormwater

This section discusses the effects of the Proposed Action on stormwater discharges and how any new construction would meet the Massachusetts Stormwater Management Regulations and other applicable regulations.

### 6.9.1 Methodology

Impacts to stormwater are generally determined based on changes in grading, surface cover, and land use. Replacing undisturbed land and vegetation with paved surfaces could affect both the quantity and quality of stormwater discharges.

Given the urban character of the project study area, the changes proposed under the Proposed Action would be on developed land rather than undisturbed sites, which greatly decreases the potential for new stormwater-related impairment. However, any increases in impervious surfaces or pollutant sources would require mitigation to ensure that the new stormwater discharges would not increase the pollutant loading or flood potential of the existing discharges. This analysis focuses on changes in urban character and increases in impervious surfaces for the Proposed Action.

### 6.9.2 No-Build Alternative

No structures would be built under the No-Build Alternative, resulting in no new impervious surfaces and no changes to stormwater flows. This alternative would require no changes to the existing municipal stormwater management systems described in Section 5.10, *Stormwater,* of this EA.

### 6.9.3 Proposed Action

At this stage of design, the discharge points and estimated impervious area changes have been determined, along with the stormwater management measures. Figure 6.9-1 shows the six proposed discharge points into the existing municipal stormwater system and the segments of the project study area that would drain to each of them. The specific sizing and construction designs of the stormwater management measures would be developed for the Proposed Action prior to construction.

The current design strives to minimize impervious surfaces through the use of the existing streets and rail corridors and by using developed sites for the stations wherever possible. The new impervious surfaces would occur within existing urbanized areas and would receive only pedestrian and bicycle traffic. Rooftop surfaces would only collect pollutants from airborne deposition. The rail corridors themselves would not create impervious surfaces as rail ballast (i.e., crushed stone) allows rapid stormwater drainage. The use of existing streets and rail corridor helps minimize the amount of impervious area required, and the removal of existing structures and pavement would partially offset the new impervious area. Additional efforts would be taken during preliminary engineering and final design in an attempt to reduce the net increase in impervious surfaces in order to minimize stormwater runoff and associated impacts.

The existing drainage system along the MBTA commuter rail corridors would have to be removed and re-installed in a different location to accommodate the shift in the commuter rail track alignment and the proposed Green Line track alignment. The new and relocated portions of the drainage system would discharge stormwater to the existing drainage trunk lines that extend beyond the railroad corridor. As with the existing drainage system, these trunk lines would continue to discharge stormwater to the Mystic River and the Charles River.

Due to the tight confines of the right-of-way, surface drainage ditches would no longer be practical in the vicinity of the proposed College Avenue Station. Instead, new underdrains would be installed within the ballast supporting the rails to collect stormwater from the right-of-way and direct it to the existing municipal stormwater systems. All proposed underdrains within the rail corridor would be 12-inch diameter perforated high-density polyethylene (HDPE) pipe and would be installed within the ballast along each side of the rail corridor with manholes located every 300 feet. Station roof drains would be connected directly to drainage trunk lines when possible. Otherwise, roof drainage would be conveyed to the trunk lines through the proposed underdrain system.

It is assumed that the Community Path project proposed by the City of Somerville would be constructed after the Green Line Extension project is completed. The proposed stormwater management system for the Green Line Extension project would be designed to handle all runoff along the corridor, including the portions of the proposed Community Path that would fall within the topographic drainage area of the project.

## Stations

Table 6.9-1 lists the net impervious surface changes estimated for each station, and each station would result in an increase of up to 0.4 acres of impervious area. These new impervious areas are associated with the pavement and rooftops of the structures and platforms that would be constructed in areas that are currently open areas of ballast or vegetated slopes within the rail corridor.

### Table 6.9-1 Impervious Surface Changes by Station

| Station | Drainage Area by Area ID[1] | Additional Impervious Area (acres) | Discharge Point into Municipal System | Receiving Water |
|---|---|---|---|---|
| Lechmere Station | 6 | 0.0 | East Street to Lechmere Channel | Charles River |
| Washington Street Station | 4 | 0.4 | New Washington Street/Inner Belt Road (Washington Street Station) | Millers River |
| Gilman Square Station | 3 | 0.4 | Medford Street (Gilman Square) | Mystic River |
| Lowell Street Station | 3 | 0.3 | Medford Street (Gilman Square) | Mystic River |
| Ball Square Station | 2 | 0.4 | Granville Avenue (northeast of Ball Square) | Mystic River |
| College Avenue Station | 1 | 0.3 | 30-inch MWRA Combined Sewer (south of College Avenue) | Mystic River |
| Union Square Station | 5 | 0.2 | Prospect Street (Union Square) | Millers River |
| **Total** | | **2.0** | | |

1 Drainage Area by Area ID are depicted on Figure 6.9-1.

The relocated Lechmere Station would not create any new impervious surfaces as the station would be elevated above the ground surface. Roadway changes in this developed area would not result in a net increase in impervious area. Stormwater runoff from this area and nearby sections of the right-of-way would discharge into the existing stormwater system located in East Street, which discharges to the Lechmere Channel located on the Charles River.

Washington Street Station would require 0.4 acres of new impervious surfaces. Stormwater runoff from this station and nearby sections of the right-of-way would discharge into the existing MBTA drainage system in New Washington Street, which connects to a CSO in Inner Belt Road and discharges to the Millers River. A subsurface detention/infiltration system could be installed near the station to maintain existing discharge rates.

Gilman Square Station and Lowell Street Station would require 0.4 acres and 0.3 acres of new impervious surfaces, respectively. Runoff from these stations and nearby sections of the right-of-way would be directed into a CSO in Medford Street at Gilman Square, which discharges to the Mystic River. A subsurface detention/infiltration system could be installed near Gilman Square Station to maintain existing discharge rates.

Ball Square Station and College Avenue Station would require 0.4 acres and 0.3 acres of new impervious surfaces, respectively. Stormwater runoff from Ball Square Station and nearby sections of the right-of-way would discharge into the existing Harvard Street drainage system west of Ball Square, which discharges into the Granville Avenue storm drain and then to the Mystic River. College Avenue Station would discharge into the 30-inch MWRA Medford-Somerville Branch Sewer. Subsurface detention/infiltration systems could be installed near these stations to maintain existing discharge rates.

Union Square Station would require 0.2 acres of new impervious surfaces. Runoff from the station and nearby sections of the right-of-way would be directed into the existing Union Square stormwater system and discharged to the Millers River. A subsurface detention/infiltration system could be installed near Union Square Station to maintain existing discharge rates.

## Maintenance and Storage Facility

Constructing the maintenance and storage facility would result in a net reduction of 3.2 acres of impervious surfaces at the 10.6-acre Option L site. This reduction would be accomplished by removing existing structures and parking and replacing them with areas of new track and ballast. Following construction of the facility, approximately 40 percent (3.4 acres) of the impervious area would be roof tops, which is expected to be clean except for airborne depositions. The stormwater management system would include many of the same features found in the station and railway drainage. Proposed management measures include:

- Deep sump catch basins to collect runoff from paved areas;
- Hydrodynamic particle separators to treat pavement runoff;
- Roof drains from building connected to an underground pipe storm drainage system;
- Underground infiltration chambers to detain and infiltrate runoff; and
- Overflow outlets from the detention chambers to direct excess flow into the existing MBTA Fitchburg Line Main Drain, which crosses the eastern portion of this site.

The stormwater system for the maintenance and storage facility would be designed to ensure no net increase in peak flow to the existing drain line, which discharges to the Millers River.

Maintenance activities (such as light rail vehicle washing) would be conducted inside the maintenance building and are not anticipated to contribute to stormwater discharges. The wastewater discharges inside the maintenance building would be collected in appropriate treatment structures such as oil and grit separators. Treated wastewater would be discharged into the sewer drain. The MBTA would coordinate with the MWRA to set up a new industrial wastewater sewer discharge.

The storage tracks would have collection trays to catch any incidental drips, leaks, or spills of hazardous materials that occur during storage or maintenance. The collection trays would be connected to an oil/water separator that would separate petroleum products from stormwater runoff prior to discharge. Any oil or other hazardous materials stored at the site would be secured with secondary containment structures to catch any spills. With the proposed containment measures in place, the maintenance and storage facility would not pose a risk to any surface or groundwater resources in the vicinity of the site.

Stormwater from the site would discharge to an existing storm drain system and would not discharge directly to any wetlands. The MBTA expects that the site will be incorporated into the existing Multi-Sector General Permit (MSGP) for Stormwater Discharges Associated with Industrial Activity for the Millers River outfall and associated conveyance system.[21] The area in its current configuration and land use is already part of the permit. The MSGP requires numerous control measures and operational plans to control spills, manage potential contaminant sources, and prevent the impairment of any water bodies receiving runoff from industrial facilities. In order to accommodate the new structures as proposed, the MSGP will require modification to the existing Stormwater Pollution Prevention Plan (SWPPP) to address maintenance and monitoring, and a Spill Prevention, Control, and Countermeasures (SPCC) plan to demonstrate vigilance and preparedness for hazardous spills.

The total maximum daily load (TMDL) for the Lower Charles River Basin identifies land uses with higher percentages of directly connected impervious area as having higher phosphorous export loading rates.[22] The 3.2-acre reduction of impervious surfaces in the Charles River watershed (from the maintenance and storage facility) supports the goal of 65 percent reduction of phosphorous loading from commercial and industrial land uses in the watershed.

## Net Effects of the Proposed Action

Table 6.9-2 summarizes the net effect of the Proposed Action on impervious surface change.

### Table 6.9-2 Summary of Impervious Surface Changes

| Changes in Impervious Area (acres)[1] | | | |
|---|---|---|---|
| Medford Branch | Union Square Branch | Maintenance and Storage Facility | Total |
| 1.8 | 0.2 | -3.2 | -1.2 |

1 Values are rounded to the nearest tenth.

21 The Multi-Sector General Permit (MSGP) is part of the National Pollutant Discharge Elimination System (NPDES) program, which requires permits for various stormwater and industrial discharges in order to prevent the contamination and impairment of receiving waters. The EPA is responsible for issuing NPDES permits in Massachusetts, and the permits are also reviewed by MassDEP. The MSGP covers most types of industrial discharges and requires general control measures as well as specific measures tailored to specific industrial uses. Industrial facilities applying for coverage under the MSGP must demonstrate compliance with all requirements and submit copies of their Stormwater Pollution Prevention Plans (SWPPPs) and Spill Prevention, Control and Countermeasure Plans (SPCCs) for review.

22 Massachusetts Department of Environmental Protection and United States Environmental Protection Agency (2007). *Final Total Maximum Daily Load for Nutrients (Phosphorus) in the Lower Charles River Basin, Massachusetts*. Page 114. Available at: http://www.mass.gov/dep/water/resources/charlesp.pdf

Given the dense urban character of the cities and neighborhoods involved, these impervious surface changes are negligible from a regional water quality perspective. However, the stormwater management system would need to be upgraded throughout the project study area to prevent localized flooding. Without proper design to control flow rates, increases in impervious area could cause the stormwater drainage system to overflow during larger storm events. The net reduction of impervious area across the project study area allows the Proposed Action to comply with the requirements of the TMDL that has been established for discharges to the Charles River.

### 6.9.4 Operations and Maintenance

The proposed stormwater management system would require regular maintenance in order to ensure its continued effectiveness. Detention systems, infiltration structures, and any water quality devices should be inspected quarterly during the first year of operation to determine the rate of sediment and debris accumulation. Afterwards, these structures would need to be inspected and cleaned at least once per year based on accumulation rates. Detailed long-term operations and maintenance plans would be developed during final design of the stormwater management system for the Green Line Extension as a whole and for the maintenance and storage facility itself.

### 6.9.5 Summary

The Proposed Action would result in an overall decrease of 1.2 acres of impervious area when compared to the No-Build Alternative. Given the existing urban environment, the proposed changes would be negligible, could be accommodated with an expanded MBTA stormwater management system for the two alignments, and would not increase the impairment or risk of flooding of the Charles River or Mystic River. Stormwater BMPs would be used during construction to minimize impacts from construction activities.

## 6.10 Fish, Wildlife, and Plants

This section discusses the effects of the Proposed Action on vegetation and wildlife habitat. The value and condition of the areas involved are based on the habitat assessment in Section 5.12, *Fish, Wildlife, and Plants*.

### 6.10.1 No-Build Alternative

No structures or tracks would be built under the No-Build Alternative, resulting in no loss of existing vegetation or wildlife habitat. The MBTA would continue to manage vegetation within the right-of-way.

### 6.10.2 Proposed Action

Vegetated areas that could be affected by the project are located along the MBTA Lowell Line. The Medford Branch would use the MBTA Lowell Line alignment and would affect varying areas of habitat used by urban wildlife. There are no vegetated areas along the MBTA Fitchburg Line alignment that would be used by the Union Square Branch.

The Proposed Action would have a direct impact to 1.7 acres of low-value habitat in areas near Gilman Square Station (0.6 acres), and Lowell Street Station (1.1 acres). As described in Section 5.12, *Fish, Wildlife, and Plants*, these areas are dominated by non-native and invasive species and provide limited wildlife habitat. These low-value habitat areas are already severely fragmented, due in part to the many bridges passing over the right-of-way that are associated with gaps in vegetated cover.

The Proposed Action would have a direct impact to approximately 1.1 acres of medium-value wildlife habitat near College Avenue Station. Even though the extended Green Line would end at College Avenue Station, these impacts would extend north of the station near Winthrop Street due to track realignment. This habitat contains a more diverse plant community and could support a greater quantity and variety of wildlife than the low-value habitat found elsewhere within the railroad corridors. The compatible habitat on opposite sides of the right-of-way near College Avenue is already fragmented by the existing tracks. Some additional habitat fragmentation would occur between College Avenue and Winthrop Street.

In total, the Proposed Action would affect 2.8 acres of vegetated areas. Given the existing urban environment, wildlife habitat is not an important function of these vegetated areas. The areas affected are limited to the right-of-way and the edges of adjacent properties and are not part of larger, continuous habitat areas. The majority of the land affected for the Proposed Action is low-value habitat that does not provide wildlife habitat benefits. None of these impacts are expected to have any effects on wildlife in the project study area.

## 6.11 Parks and Recreation Areas

The Proposed Action would directly impact one park by increased noise levels, which would be mitigated by a sound barrier. As summarized below, prior to mitigation increased noise levels at Trum Playground would result in a moderate impact to this site. No other direct or indirect impacts to parks or recreation areas would result from the Proposed Action.

Section 6.7.2, *Noise Impacts*, Table 6.7-1, *Potential Noise Impacts Prior to Mitigation (dBA)*, shows that prior to mitigation noise levels at Trum Playground would increase from 68.6 Ldn to 72.0 Ldn, a moderate impact according to FTA criteria. The relocated commuter rail line would be 36 feet from the playground, while the new Green Line Extension would be 67 feet away. Information on the proposed noise mitigation at Trum Playground is provided in Section 7.3.4, *Noise*.

This evaluation does not address the Community Path, a planned 2.5-mile extension between the Minuteman Bikeway and Cambridge Linear Park to the Charles River Path and downtown Boston, which would abut portions of the MBTA Lowell Line and the Medford Branch of the Green Line Extension. This multi-use path would provide additional opportunities for bicycling, walking, jogging, and inline skating.

Chapter 8, *Section 4(f) Evaluation* of this EA, provides a complete evaluation of the project's compliance with Section 4(f) of the U.S. DOT Act of 1966.[23] The Proposed Action would not directly impact or result in a constructive use of any Section 4(f) park or recreation area. As stated in Chapter 7, *Project and Mitigation Commitments* of this EA, barriers to mitigate noise at Trum Playground and near the Park at Somerville Junction and the Hoyt-Sullivan Playground would effectively eliminate any direct noise impacts to these resources to a condition equivalent to, or better than, that which would occur if the project were not built. The proposed noise barriers would be effective in mitigating all potential noise impacts from the project, and no residual impacts would be expected.

## 6.12 Visual Environment

This section discusses the potential visual effects for the No-Build Alternative and the Proposed Action. The existing visual environment in the project study area is discussed in Section 5.14, *Visual Environment*.

### 6.12.1 No-Build Alternative

There would be no construction under the No-Build Alternative, resulting in no changes to the visual environment.

### 6.12.2 Proposed Action

The Proposed Action would require demolishing buildings, constructing new Green Line track and stations, constructing a new maintenance and storage facility, and relocating the commuter rail track within the existing right-of-way. Some existing vegetation would be removed, and new retaining walls and noise barriers would be built. Each of these elements would be visible to the public.

23 Section 4(f) of the United States Department of Transportation Act of 1966 (Amended March 12, 2008 in 73 FR 13395; implemented at 23 U.S.C. 138 and 49 U.S.C Section 303(c)).

Fences, trees, and steep slopes on each side of the right-of-way would minimize the rail corridor's visibility. For the majority of the extension, the rights-of-way are only visible to the public from certain locations, such from bridges or through fences. Since the changes would occur in urbanized areas within and adjacent to the existing right-of-way, they would result in little overall impact to the visual environment for the public. New planting and screening efforts along the right-of-way and atop the retaining walls would be done in coordination with abutting residents and businesses to ensure that no undue visual impacts are imposed on local neighborhoods. The project would incorporate vegetation in and above these walls and at the stations in order to maximize the amount of vegetation along the expanded right-of-way. These would reduce the net loss of vegetation and reduce the visual impact of any tree removal on the neighborhood. The retaining wall design, including any vegetated features, would be developed in the final design for the Proposed Action.

The OCS to power the Green Line Extension would include support poles up to 22 feet high within the rights-of-way. The poles and lines of the OCS would be an introduction of new visual elements in the railroad corridor, but would not substantively change the appearance of the corridor.

The stations themselves would be along and within the rights-of-way to the greatest extent possible, minimizing the overall visual impact. The major construction materials used in the stations themselves would be masonry, steel, and glass. Landscaping would be designed to provide protection from weather for passengers without obscuring visibility. Landscaping would be inviting both to the users of the stations and to the passers-by, using small trees and low shrubs, which are easily maintained and of a design which encompasses lighting and defensible space for safety. The new stations would be visible from their street access points and from nearby bridges. Consultation with the MHC and the relevant historical commissions will ensure the design of the Gilman Square Station and Lowell Street Station is context-sensitive to the nature of the National Register-eligible Gilman Square Historic District and the National Register-eligible Powder House/Winter Hill Historic District near these stations.

For the relocated Lechmere Station, the northernmost end (steel portion) of the Lechmere Viaduct would be demolished, and the reconstructed segment would descend to ground level beyond the new station site. The removal of the steel segment of the Lechmere Viaduct over Monsignor O'Brien Highway would be a positive visual effect. This segment is located partially within the Charles River Historic District as described in Section 6.13.1, *Historic Resources*. The existing Lechmere Station and bus garage would also be demolished, and the site would be available for redevelopment.

The reconstructed viaduct and relocated Lechmere Station would be new structures within this area, but would not change the nature of the visual environment for most observers. However, the new viaduct, station, and track in this short segment would be immediately adjacent to the east side of the Glass Factory Condominiums and the Hampton Inn. The developed visual environment immediately adjacent to the east side of the Glass Factory Condominiums and Hampton Inn would be changed by the addition of the new viaduct, relocated Lechmere Station, and Green Line Extension tracks as they descend to ground level.

As described in Section 7.3.4, *Noise*, the Proposed Action would require some degree of noise mitigation, usually consisting of noise barriers to protect sensitive receptors such as residences from increases in train noise. Noise barriers would range from six to 12 feet tall and would block the view of the right-of-way for adjacent homes. While this would reduce the visibility of the green space surrounding the right-of-way, it would also prevent any further visual impacts by obscuring the trains and rails that would otherwise be visible from residential back yards. Consultation with the MHC and the relevant historical commissions will ensure the design of the noise barrier behind the National Register-listed Susan Russell House is context sensitive.

The maintenance and storage facility would be located at the Option L site in Somerville's Inner Belt industrial area. The facility would be used to store Green Line train cars when not in use, and an adjacent support facility building would be required for actual maintenance activities. Constructing the facility would require demolishing two buildings and constructing a new building. Given the existing industrial and commercial buildings visible from this area, the support facility would result in a minor change to the local landscape. The new building would be enclosed, resulting in minimal light exposure to the surrounding area. Any outdoor lighting would be directed downward and towards the building with fixture hoods to prevent any direct lighting impacts at night on neighboring buildings.

The aesthetic features of the exterior of the structure would enhance the possibility of quality redevelopment nearby. Visual screening by landscaping or walls would be considered, especially adjacent to the outdoor rail car storage area. Consideration would be given to the development of a deck for parking or other purposes over the storage yard, which would provide weather protection to the Green Line cars while screening the visual impacts.

Due to the urbanized character of the portions of Cambridge, Somerville, and Medford through which the Green Line Extension passes, there would be no major changes to the existing context of the project area.

The local community would experience temporary visual impacts during construction. Portions of the Proposed Action would be visible to the general public while under construction, such as the station sites and bridge locations. Construction equipment and materials, personnel, and traffic control measures would be present temporarily, changing the visual environment during the construction period. When the construction period is complete, the visual environment would be left as described above.

### 6.12.3 Summary

- The Proposed Action would not have a major effect on the local visual environment throughout the majority of the corridor. The visual changes proposed under the Proposed Action would occur in urbanized areas within and adjacent to the existing rights-of-way. The most noteworthy changes would be:
- The loss of vegetated areas along the right-of-way, reducing the green space visible from local residential areas.
- The addition of landscaping at the stations and both on and above the retaining walls, which would reduce the overall visual effect of vegetation losses.
- The introduction of the OCS to power the Green Line trains, which would require support poles up to 22 feet high within the rights-of-way.
- The introduction of the maintenance and storage facility, which would introduce an additional industrial building to a largely commercial/industrial neighborhood.
- The proposed noise barriers, which would block the view of the right-of-way for adjacent homes and prevent any further visual impacts by obscuring the trains and tracks that would otherwise be visible from residential back yards.

## 6.13 Cultural Resources

This section describes the potential impacts from the No-Build Alternative and the Proposed Action to cultural resources, and steps that can be taken to eliminate, reduce, or mitigate adverse impacts to historic, architectural and archeological resources that are listed or determined eligible for listing in the National Register. In compliance with Section 106 of the NHPA the potential effects of the project on these resources was coordinated with the MHC in its role as State Historic Preservation Officer (SHPO) and the other consulting parties. The SHPO reviewed the studies provided and concurred with the effect determinations. The stipulations listed to mitigate the adverse effects to the properties were concurred with in a letter from SHPO on July 12, 2011. A Memorandum of Agreement (MOA) was prepared in coordination with the SHPO, Cambridge Historic Commission, and Boston Landmarks Commission. The MOA and SHPO letter dated July 12, 2011 are both provided in Appendix G, *Memorandum of Agreement*. The MOA will be finalized and executed prior to the issuance of the final document. The historic resources reconnaissance survey is provided in Appendix I, *Historic Resources Reconnaissance Survey and Historic Resources Intensive Survey*. A U.S. DOT Section 4(f) Evaluation is provided in Chapter 8, *Section 4(f) Evaluation*, of this EA.

### 6.13.1 Historic Resources

Figures 6.13-1 through 6.13-9 show the locations of the historic properties and proposed noise and traffic mitigation measures.

#### No-Build Alternative

The No-Build Alternative involves no changes to existing conditions or service and therefore would have no effect on historic resources.

#### Proposed Action

Seven historic resources would be adversely affected by the Proposed Action. The MBTA will ensure that the design plans and construction specifications that affect these historic properties or historic districts are context-sensitive and are submitted to the SHPO, the local historic commissions, and the corridor-wide Design Working Group prior to construction for review and comment.

##### Lechmere Viaduct

With the exception of the steel elevated portion of the Lechmere Viaduct in Cambridge, no National Register-listed or eligible cultural resources located within the existing railroad rights-of-way would be directly impacted by the Proposed Action (Figure 6.13-1). The Lechmere Viaduct structure is eligible for listing in the National Register. Demolishing the steel portion of the viaduct would be a permanent and adverse impact, which would require mitigation. The SHPO has concurred with this finding. The demolition of this structure is unavoidable as there are no practicable alternatives to build the Proposed Action.

##### Charles River Basin Historic District

The Lechmere Viaduct described above is a contributing structure to the National Register-listed Charles River Basin Historic District (Figure 6.13-1). Although the existing Lechmere Station and the steel portion of the Lechmere Viaduct (to be demolished as part of the Proposed Action) are outside the documented district boundaries, the steel portion (in Cambridge) and the adjoining concrete portion (in Boston) of the viaduct are considered by the SHPO a contributing structure. There would be no direct impact to the concrete portion of the viaduct as part of the Proposed Action. Adverse effects to the Lechmere Viaduct therefore impact the district. SHPO has determined that the National Register-listed Charles River Basin Historic District would be adversely impacted by the demolition of the steel portion of the Lechmere Viaduct.

### Lechmere Station

Abandoning and demolishing the existing Lechmere Station at the end of the viaduct would adversely affect Lechmere Station, which is eligible for listing on the National Register (Figure 6.13-1). This unavoidable action was determined an adverse effect, requiring mitigation. The SHPO has concurred with this finding.

Prior to any demolition or construction activities, archival photographic documentation of the Lechmere Station area and the Lechmere Viaduct will be prepared by a qualified historic preservation consultant, in consultation with the SHPO and relevant historical commissions. In addition, the MBTA will develop interpretative displays, in consultation with the FTA, the SHPO and relevant historical commissions, to be located at the site of the proposed relocated Lechmere Station. This interpretative display will discuss the history of Lechmere Station, the adjacent Lechmere Viaduct, elevated railway, and their appropriate historic contexts using text, photographic images, and maps.

Constructing the maintenance and storage facility at the Option L site in Somerville's Inner Belt industrial area would not affect historic properties (Figure 6.13-1).

### Gilman Square Historic District

Gilman Square Station is located in the National Register-eligible Gilman Square Area Historic District. A portion of the Reid and Murdock Company Warehouse property (a National Register-eligible property that is a contributing element to the Historic District) would be acquired (Figure 6.13-5). To construct the Gilman Square Station, a non-contributing railroad loading dock at the rear of the building would be removed and an adjacent parking area would also be acquired. In addition, access to a three-bay garage would be blocked by the proposed station driveway. SHPO has concurred that this would not be an adverse effect to the Reid and Murdock Company Warehouse building. However, the Proposed Action would have an adverse effect on the Gilman Square Historic District. The design plans for the station will be coordinated with the local historic commission and SHPO to minimize the effects to the District.

Constructing the new Gilman Square Station would also introduce new visual elements in the vicinity of the National Register-eligible Gilman Square Historic District (Figure 6.13-5). The station would be at track level in the right-of-way cut between the backs of an industrial building and the Somerville High School/City Hall/Library area. The introduction of the visual elements within the Gilman Square Historic District was determined to be an adverse effect, requiring consultation with the SHPO and Somerville Historic Preservation Commission during design and construction of the station.

### Susan Russell House

The Susan Russell House is a National Register-listed property that would be adversely impacted by the Green Line Extension based on the criteria for noise impacts as defined by the FTA. While the project would not directly modify the National Register-listed property, the construction of a noise barrier wall proposed within the existing railroad right-of-way near the Susan Russell House would visually impact the property (Figures 6.7-3 and 6.13-6). The design of the noise wall will be context-sensitive and coordinated with the SHPO and relevant historical commissions, as documented in the MOA (Appendix G, *Memorandum of Agreement*). Noise barriers and track vibration isolation would be effective in reducing potential noise impacts at this property, resulting in no residual noise impact. The increase in noise would not alter the characteristics that qualify the Susan Russell House for listing in the National Register. No mitigation measures for insulating sound at individual historic buildings are currently proposed.

### Powder House/Winter Hill Industrial Area Historic District

Constructing the new Lowell Street Station would introduce new visual elements in the vicinity of the National Register-eligible Powder House/Winter Hill Industrial Area Historic District (Figures 6.13-6 and 6.13-7). The introduction of the visual elements within the Powder House/Winter Hill Industrial Area Historic District was determined to be an adverse effect, requiring consultation with the SHPO and Somerville Historic Preservation Commission during design and construction of the stations. In addition, a cultural resources survey of the Powder House/Winter Hill Industrial Area Historic District will be conducted to reevaluate the current district boundaries and eligibility for listing in the National Register.

### Somerville Automobile Company

For the Ball Square Station, the Somerville Automobile Company building (a National Register determined-eligible property) would be acquired and demolished (Figure 6.13-7). This unavoidable impact is determined an adverse impact, requiring mitigation. There are no practical alternatives that would be less damaging to cultural resources. The SHPO has concurred with this finding. Prior to any demolition or construction activities, archival photographic documentation of the Somerville Automobile Company building will be prepared by a qualified historic preservation consultant, in consultation with the SHPO and relevant historical commissions. In addition, the MBTA will develop interpretive displays, in consultation with the FTA, the SHPO and relevant historical commissions, to be located at the site of the proposed Ball Square Station. This interpretative display will discuss the history of the surrounding Medford/Somerville communities, the Somerville Automobile Company building, and the role that the automobile and streetcar in general contributed to the development of the area.

### Construction Impacts

Construction impacts to historic resources from the Proposed Action are expected to include noise, vibration, dust, visual, construction traffic, and traffic management. Mitigation measures to offset these impacts are described in Chapter 7, *Project and Mitigation Commitments*. These impacts would be temporary and terminate when construction is complete. Construction would have no permanent effect on historic architectural resources and therefore does not result in an adverse effect to the historic resources.

## 6.13.2 Archaeological Resources

The potential impacts to archeological resources for the No-Build Alternative and the Proposed Action are described below.

### No-Build Alternative

The No-Build Alternative involves no changes to existing conditions and service and, therefore, would have no effect on archeological resources.

### Proposed Action

There are no known archeological resources that would be disturbed by the Proposed Action. Two areas of archeological sensitivity were previously identified within the project APE. The Washington Street Station (formerly known as Brickbottom Station) was relocated to avoid impacting the archeologically sensitive strata between Joy Street and the railroad right-of-way in Somerville. These locations are known to previously contain mid to late nineteenth century worker housing. Project construction would not affect this area. Subsequent investigations found that there is extensive fill and/or previously disturbed belowground soil contexts in the vicinity of the Option L maintenance and storage facility site, which makes it unlikely that intact archeological resources would be discovered in this location during construction. However, should any unidentified archeological resources be discovered during construction, MassDOT would ensure that appropriate notification and preservation procedures are followed, as stipulated in the MOA (Appendix G, *Memorandum of Agreement*).

No other areas of archeological sensitivity were identified for the Green Line Extension project APE because of the presence of extensive fill and/or previously disturbed belowground soil contexts.

## 6.13.3 Regulatory Compliance

In compliance with Section 106 of the NHPA, U.S. DOT Act Section 4(f), and other Federal and state statutes, historic resources were identified and evaluated through archeological and historic architectural surveys. The SHPO, the Cambridge Historical Commission, the Somerville Historic Preservation Commission, and the Medford Historical Commission were contacted to identify and evaluate potential impacts to the historic and archaeological resources. Consultation will continue in order to consider alternatives and measures that would avoid, minimize, or mitigate any adverse effects of the project on National Register-listed or eligible historic and archeological resources.

An MOA (Appendix G, *Memorandum of Agreement*) specifies the measures that would be implemented to mitigate the adverse effects. Signatories to the MOA are the FTA and the SHPO. Invited Signatories are MassDOT and the MBTA; Concurring parties are the Boston Landmarks Commission, the Cambridge Historical Commission, Medford Historical Commission, and the Somerville Historic Preservation Commission.

### 6.13.4 Summary

- The Proposed Action would have an adverse effect on seven historic resources listed or eligible for listing on the National Register of Historic Places:
  - National Register-eligible Lechmere Viaduct in Boston and Cambridge (for acquisition and demolition of the steel elevated portion);
  - National Register-listed Charles River Basin Historic District in Boston and Cambridge (for acquisition and demolition of a portion of a contributing structure, the Lechmere Viaduct);
  - National Register-eligible Lechmere Station in Cambridge (for abandonment and demolition);
  - National Register-eligible Gilman Square Historic District in Somerville (for potential visual impacts due to the proposed Gilman Square Station);
  - National Register-listed Susan Russell House in Somerville (for potential visual impacts resulting from noise barriers);
  - National Register-eligible Powder House/Winter Hill Historic District in Somerville (for potential visual impacts due to the proposed Lowell Street Station); and
  - National Register-eligible Somerville Automobile Company in Medford and Somerville (for acquisition and demolition).

There are no known archeological resources that would be disturbed by the Proposed Action. However, should any unidentified archaeological resources be discovered during construction, MassDOT would ensure that appropriate notification and preservation procedures are followed, as stipulated in the MOA.

## 6.14 Hazardous Materials and Solid Waste

This section describes how contaminated soil, if present, would be evaluated, managed, and disposed, and summarizes the Proposed Action and potential OHM impacts. Also included is a discussion of the relative effects based on the Recognized Environmental Conditions (RECs) that were identified in Section 5.16, *Hazardous Materials and Solid Waste*, as well as the results of the soil sampling that was performed from February to November 2010 as part of the pre-characterization and assessment program.

### 6.14.1 No-Build Alternative

No construction would be performed under the No-Build Alternative; therefore, no contaminated media would need to be managed, which eliminates the possibility of any hazardous materials impacts.

### 6.14.2 Proposed Action

The Proposed Action would require construction, including soil removal, within the existing MBTA Fitchburg and Lowell Lines, and the Option L site for the maintenance and storage facility (a former rail property). Station construction would largely be within the existing right-of-way; however, up to 40 properties would need to be acquired (in part or in full) for station construction, including the demolition of up to eight buildings. Phase I ESAs conducted for these properties identified 28 RECs that would be addressed during construction. Potential impacts include encountering contaminated soils or groundwater; disposing of contaminated materials; and disposing of solid waste containing lead-based paint, asbestos, or other regulated materials.

One potential environmental concern or *de minimis* condition has been identified for the majority of the buildings located on the properties to be demolished, based on the age of the buildings. Asbestos-containing materials, including roof flashing, tiles, and other materials, could be present in many buildings. In addition, lead-based paint, mercury, and PCBs could also be present in the building materials and/or fixtures.

Five of the RECs were evaluated as having a "high" impact, 15 RECs were evaluated with "medium" impacts, and eight RECs were evaluated as having "low" impacts. Table 6.14-1 lists each of the RECs by station/facility location on the Medford Branch and Table 6.14-2 lists each REC on the Union Square Branch.

## Table 6.14-1 RECs and Potential Impacts for the Proposed Action - Medford Branch

| Station/Facility | REC(s) | RTN(s) | Relative Impact |
|---|---|---|---|
| Maintenance and Storage Facility | Releases at Yard 8 | 3-4222 | High |
| | Release of Petroleum at 100 Inner Belt Road and Petroleum Storage at 70 Inner Belt Road (currently the same parcel) | 3-974 | High |
| | Historic Use of Site at Rail Yard | Not applicable | Medium |
| | Use of 48 Third Avenue as a Printing Facility | Not applicable | Medium |
| | Former Condition of 150-200 Inner Belt Road | Not applicable | Medium |
| | Release of Arsenic and PCBs at 120 Inner Belt Road | 3-19075 | Medium |
| | Releases and Current Use of MBCR Maintenance Facility at 70R Third Avenue | See below* | Medium |
| Washington Street | On-Site Releases at 4 Joy Street | 3-11444, 3-13082, and 3-23562 | High |
| | Petroleum Storage at Site | Not applicable | High |
| | Historic Use of Site for Vehicle Repair and Maintenance | Not applicable | Medium |
| | Former Use of Adjacent Property (100-120 New Washington Street) for Petroleum Products Storage | Not applicable | Medium |
| | Release at Nearby Property Near Yard 8 | Not applicable | Medium |
| | Off-Site Release at 50 Tufts Street | 3-23246, 3-24358, 3-24376, 3-26114 | Medium |
| Gilman Square | Release at Somerville High School, 81 Highland Avenue | 3-26487 | Medium |
| | Potential of a Underground Storage Tank at the Homan's Building | Not applicable | Medium |
| | Release at 350 Medford Street | 3-17076 | Low |
| Lowell Street | Underground Storage Tank Located at 20 Vernon Street | Not applicable | Medium |
| | Historic and Current Use of 20 Vernon Street | Not applicable | Medium |
| Ball Square | Historic Use of 662-664 Boston Avenue Property as Auto Repair Garage | Not applicable | Medium |
| | Release at 294 Harvard Street | 3-833 | Low |
| | Release at Shell Service Station, 620 Broadway | 3-1322 | Low |
| | Release at Analetto Brothers, 590 Broadway | 3-18017 | Low |
| College Avenue | Release and Historic and Current Use of 175-179 College Avenue Buildings | 3-17417 | Low |
| | Historic Use of Building Adjacent to 474 Boston Avenue as a Chemical Laboratory | Not applicable | Low |

* N90-1956, N90-0236, N90-1810, N93-0627, N93-0705, RTN 3-24428, 3-22276, 3-26988, 3-22964, and 3-23114.

## Table 6.14-2 RECs and Potential Impacts for the Proposed Action - Union Square Branch

| Station | RECs | RTN(s) | Relative Impact |
|---|---|---|---|
| Union Square | Historic Use of 51 Allen Street, Previous Existence of USTs, and Release Site | 3-24339 and 3-24921 | High |
| | Releases of PCBs and Other Contaminants at Nearby Properties | 3-2849, 3-16632, and 3-22153 | Medium |
| | Underground Storage Tanks at 120 McGrath Highway | Not applicable | Low |
| | Underground Storage Tanks at One Fitchburg Street | Not applicable | Low |

## Soil Pre-Characterization and Assessment

Limited Phase II subsurface investigations were recommended to address the RECs listed in Table 6.14-2 and pre-characterize soil in areas where soil disturbance would occur during construction of the Green Line Extension project. As part of the larger geotechnical boring program, which was conducted by Parsons Brinckerhoff from February to November 2010, a total of 129 soil borings were selected for environmental evaluation. At these locations, samples were obtained and analyzed for one or more of the following: Extractable Petroleum Hydrocarbons (EPH) with target PAHs, VPHs with target VOCs, VOCs via EPA Method 8260B, PCBs, and MCP 14 Metals. The geotechnical boring program was conducted primarily within the existing railroad right-of way.

During the geotechnical program, levels of OHM in several soil samples were found to exceed applicable regulatory thresholds as set forth in the Massachusetts Contingency Plan (310 CMR 40.000) and regulated by the MassDEP. Table 6.14-3 summarizes RTNs assigned to OHM identified subject to reporting in accordance with the MCP, including the approximate location of the release and contaminants of concern.

**Table 6.14-3 Findings of Right-of-Way Subsurface Assessments**

| Nearby Station/Bridge | RTN(s) | COCs[1] |
|---|---|---|
| Relocated Lechmere Station | 3-29416 | Arsenic |
| Former Red Bridge | 3-29540, 3-29541 | Mercury, Arsenic, PAHs |
| Washington Street Station/Bridge | 3-29537, 3-29538 | Chromium, Nickel, EPH fractions |
| Walnut Street Bridge | 3-29586 | One PAH (2-Methylnaphthalene), one VOC (Methyl-tert butyl ether) |
| Medford Street Bridge (NH Mainline) | 3-29612 | PAHs |
| Gilman Square Station | 3-29615 | Chromium, Nickel, Lead |
| School Street Bridge | 3-29617 | One PAH (Benzo(a)pyrene), Arsenic, Nickel |
| Lowell Street Station/Bridge | 3-29613, 3-29614 | PCBs, Chromium, Lead, Nickel, PAHs |
| Ball Square Station | 3-29528 | Arsenic, PAHs |
| College Avenue Station/Bridge | 3-29733, 3-29734 | EPH fractions, Cadmium |
| Medford Street Bridge (Fitchburg Line) | 3-29611 | PAHs, Chromium, Nickel |
| Union Square Station | 3-29585 | VPH and EPH fractions, PCBs, Arsenic, Cadmium, Lead, Nickel, Zinc |
| Union Square Branch | 3-29539 | Arsenic, Lead |

1 Contaminants of Concern

## Management of Contaminated Media and Regulatory Compliance

Based on their age, asbestos-containing materials, including roof flashing, tiles, and other materials could be present in the buildings that would be undergoing demolition. In addition, lead-based paint, mercury, and PCBs could also be present in the building materials and/or fixtures. It is recommended that prior to demolition, a licensed asbestos and hazardous materials contractor sample the building material, including roof flashing, tiles, and other materials, as well as the potential lead-based paint, mercury, and

PCBs. If these hazardous materials are found to be present in the structures, then they must be removed by a licensed contractor in accordance with state regulations.

In addition, health and safety procedures must be performed under the guidelines of the Occupational Safety and Health Administration (OSHA). All construction workers involved in performing the response actions must be appropriately health and safety trained in accordance with the applicable provisions of OSHA, which mandates specific procedures that must be followed to be protective from exposure to contaminated media.

Prior to soil excavation, additional subsurface investigations and soil testing may be done in all areas where soil disturbance would take place within the rail rights-of-way for the construction of the Green Line Extension, as contaminated media could be present due to reported releases and unidentified OHM impacts such as the presence of urban fill.

Soil impacted with OHM generated during the implementation of the Green Line Extension project would be managed appropriately in accordance with MBTA's *Design Construction Standard Specifications*, Section 02282, *Handling, Transportation and Disposal of Excavated Material*. Preliminary assessment activities could assist in identifying the type and quantity of OHM-impacted media which would require management under these protocols and help select the optimal disposal methods and/or destination prior to generation. The MBTA specifications are summarized below.

## Soil

Should OHM-impacted soil that requires export or on-site re-use be generated during excavation activities, this material would be properly characterized and managed in accordance with applicable regulations. Proper management would ensure appropriate re-use on the project site to prevent exposure to contaminants or export to an appropriate destination(s). Characterization could entail the collection of soil samples and analysis for parameters specified in MassDEP policies for reuse and disposal of contaminated soil. Any excess soil should be stockpiled onsite pending characterization and, if export is needed, generation of the required paperwork.

To facilitate characterization, the soil can be segregated into approximately 500-cubic yard sections and placed on and covered with polyethylene sheeting of 10 mil or greater thickness. Covers shall be placed on each stockpile at the end of each day's operations, and shall be secured in place to prevent runoff and erosion. A composite soil sample would be collected from each of the sections. The soil samples may be submitted, at a minimum, for one or more of the following chemical analyses: "RCRA 8" metals using Method 6010/7471, VOCs via EPA Method 8260, PCBs via EPA Method 8081, TPH via modified EPA Method 8100, SVOCs via EPA Method 8270, reactive cyanide and sulfide using EPA Method SW-846, ignitability using EPA Method 1010, corrosivity using EPA Method 9045, and conductivity using EPA Method 120.1. Any samples found to contain contaminant concentrations equal to or greater than 20 times their hazardous waste toxicity threshold (*i.e.*, the 20-times rule) shall be analyzed by the toxicity characteristic leachate procedure (TCLP).

It is assumed that analyzing samples for pesticides and herbicides would not be required; however, this assumption could be modified based on the requirements of the disposal facility and history of the generator site. Should alternate soil disposal options such as asphalt batching be pursued, analytical requirements could vary depending on the analytical requirements for that facility. Based on the results of the characterization, a Bill of Lading would be prepared to facilitate the export of the soil to the selected disposal facility. The Bill of Lading would need to be prepared and/or certified by a Licensed Site Professional (LSP).

#### Groundwater

If OHM-impacted groundwater is encountered and generated during the project, it would also need to be managed in accordance with applicable regulations. If the volume would be limited and subsequent offsite disposal is deemed to be the most cost effective disposal option, the groundwater can be temporarily stored in a 21,000-gallon fractionation tank. It would then be characterized, at a minimum, via laboratory analysis for the following parameters: VOCs via EPA Method 8260, TPH via EPA Method 8100, and SVOCS by EPA Method 8720. For managing larger volumes of groundwater, it could be more cost effective to obtain an EPA Construction General Permit or Remediation General Permit for discharge to surface waters/storm drains or a permit from the local sewer authority, if allowed, for discharge to sanitary sewers.

### 6.14.3 Summary

The Proposed Action would be beneficial to the environment and human health by remediating areas of contaminated soils at sites where excavation activities encounter these soils.

Up to 40 properties would need to be acquired (in part or in full) for station construction, including the demolition of up to eight buildings. Phase I ESAs conducted for these properties identified 28 RECs that would be addressed during construction. Therefore, the actual severity of each REC and associated impact to the project will be assessed at the completion of Phase II subsurface investigations currently being conducted in order to better estimate disposal costs and potential regulatory obligations. MassDOT would consult with the MassDEP regarding the planning and implementation of demolition and management of contaminated soil to ensure consistency with the applicable regulations.

The recommendations for mitigation measures during construction could include special handling, dust control, and management and disposal of contaminated soil and groundwater in order to prevent construction delays and to provide adequate protection to workers and any nearby sensitive receptors.

## 6.15 Indirect and Cumulative Effects

The CEQ regulations at 40 CFR 1500 *et seq* require an assessment of indirect and cumulative impacts for Federally assisted projects. This section provides an assessment of the indirect and cumulative effects of the project and other ongoing and planned projects in the project study area and the surrounding region.

### 6.15.1 Methodology

The project has the potential to produce indirect effects and, when combined with past, present and other reasonably foreseeable future projects, could result in cumulative effects to certain resources. Indirect effects anticipated from the project would result from possible redistribution of growth and changes in development densities. A qualitative assessment of indirect effects was based on land use analyses, field inspections and information provided by planning departments in Cambridge, Somerville, and Medford and the MAPC regarding future development.

Federal guidance was used in evaluating the project's cumulative effects, specifically CEQ's *Considering Cumulative Effects under the National Environmental Policy Act* (CEQ 1997).

#### Timeframe for the Analysis

The timeframe for the cumulative impacts analysis included two components: the time period covering past, known effects and a period covering future, predicted effects. The time period of the past analysis is the time since the start of the project study area's development (1840-1920). Modest growth occurred in the project study area after 1920, with a few exceptions: substantial redevelopments in east Cambridge starting in the 1980s (Kendall Square, Lechmere, the east Cambridge waterfront, and NorthPoint), and redevelopment of the Inner Belt District in Somerville after the land was cleared in the 1960s for the Inner Belt Highway. Based on this history, the beginning year for indirect and cumulative effects analysis is 1980. The time for future effect analysis extends from the present day to the reasonably foreseeable year of 2030, the forecast year for the Green Line Extension.

#### Geographic Limits for the Analysis

Geographic areas of effect are typically discussed in three categories:

- **Project Region**: The project region encompasses the entire municipal areas of Cambridge, Somerville, and Medford (Figure 1.1-1).
- **Project Study Area**: The project study area is generally bounded by interstate I-93 and the MBTA Orange Line to the east, the MBTA Red Line and

MBTA Fitchburg Line commuter rail right-of-way to the west and south, and the MBTA West Medford commuter rail station to the north (Figure 1.1-1).

- **Station Areas**: Station areas are within one-half mile of a proposed station site, which is generally considered easy walking distance (Figures 5.2-2 through 5.2-8).

Indirect effects of the project are likely to occur within the station areas. The station areas are where the greatest changes in access to the transit system would occur; these are also likely to be the areas where development and change in development densities can be reasonably expected in response to the project.

The cumulative effects analysis considers both the project study area and project region. Foreseeable projects and developments in the project study area are incorporated in the analysis.

### 6.15.2 Corridor-wide Indirect Effects

Future development would be greatly influenced by factors outside the control of MassDOT and the MBTA. The economy of the U.S. and technology trends can affect the economy of Massachusetts and how, when, and to what degree land is developed in the project. The growth projections in the project study area are predicated on current information. Actual growth could be more or less than projected.

The project region has a strong base in economic sectors that are growing and are projected to experience continued growths in education, information technology, life sciences, and the arts. Regardless of whether the project is built or not, the Cities of Cambridge and Somerville anticipate considerable economic growth and redevelopment along the project study area. They also anticipate growth in areas outside the project study area.

Based on analysis of data provided by MAPC (2008), 32 percent of the three municipalities' total population of 234,909 in 2000 was located within walking distance (one-half mile) of the proposed stations. Assuming the No-Build Alternative, by 2030 the population in these three cities is projected to increase by 16 percent to 272,925, with 32 percent residing within walking distance of the project study area. This level and concentration of growth within the project study area is consistent with public policy and plans. These data are shown in Table 6.15-1.

**Table 6.15-1 Cambridge, Somerville, Medford and Station Area Populations (2000 and 2030)**

| | Population | |
|---|---|---|
| | 2000 | 2030 No-Action Alternative |
| Cambridge | 101,650 | 124,419 |
| Somerville | 77,493 | 88,926 |
| Medford | 55,766 | 59,580 |
| Total | 234,909 | 272,925 |
| Population in the Station Areas (within one-half mile of a proposed Green Line station) | 74,711 | 87,429 |

Source: 2000 estimates and 2030 projections by municipality and Transportation Analysis Zone (TAZ) prepared by MAPC, August 2008. Station Area values were calculated by overlaying the one-half mile radius zones on the TAZs and assuming the population within a TAZ is proportional to its area.

## 6.15.3 Indirect Effects

The Proposed Action is unlikely to generate additional regional growth in jobs or population. However, the Proposed Action could affect where that growth occurs, the form of the growth, and the pace of redevelopment.

At the project study area level, the Proposed Action would support a number of major redevelopment projects that are planned and underway near the proposed station sites (Table 6.15-2), particularly in the NorthPoint area of Cambridge. Improved mobility, access to a wider range of transportation options, and less traffic congestion relative to the No-Build Alternative would make these projects particularly appealing.

Within the station areas, the Green Line Extension combined with supportive public policies could attract transit-supportive development that would otherwise locate outside station areas in less transit-supportive forms. If the Proposed Action is implemented, it is likely that Cambridge, Somerville, and Medford would adopt zoning rules that would allow for more dense development around transit stations relative to existing conditions and surrounding areas. Cambridge and Somerville have already taken steps in this direction. The NorthPoint, Union Square, and the developing Brickbottom and Inner Belt area plans in particular stress development in concert with the project.

Indirect effects of the proposed maintenance and storage facility for the project are likely to be varied. The facility is to be sited immediately adjacent to and northwest of the MBTA's commuter rail maintenance facility, also referred to as the Boston Engine Terminal. The Option L site is along the southern and southeastern fringe of the existing Inner Belt industrial area of Somerville.

## Table 6.15-2 Proposed and Reasonably Foreseeable Projects in the Project Corridor

| Project Name and/or Location[1] | Description | Effects | Status |
|---|---|---|---|
| **Lechmere Station Area:** | | | |
| 1. NorthPoint, Cambridge | Private, 45-acre mixed-use development of 329 residential units and a 5-acre central park. Future work includes 2,371 residential units, 2.1 million square feet of office/lab space, and 75,000-square feet of retail space. | Project would increase development density near the station. Higher densities, especially office uses, would increase ridership potential. | Planned |
| 2. 22 Water Street, Cambridge | Private redevelopment to create 392 residential units in high-rise towers with structured parking. | Project would increase residential density near the station by redeveloping vacant properties. | Planned |
| 3. Archstone-Smith Phase II, Cambridge | Phase II of a private development to create 426 residential units in addition to the recently completed 437 units. | Project would increase residential density near the station. | Planned |
| 4. Redevelopment of Existing Lechmere Station site | Proposal by state to redevelop existing Lechmere Station site for residential (90,000-square feet) and hotel (90,000-square feet) uses. Permitted as part of NorthPoint. | Project would increase density near the station. | Planned |
| 5. Binney Street Life Sciences Development, Cambridge | Proposal by a private developer to redevelop 16-acres of industrial land over the next 10 years to create 1.5 million square feet of laboratory and office space for life sciences. | Project would increase employment density near the station. | Planned |
| 6. Reconstruction of McGrath Highway/Route 28 | A concept favored by the City of Somerville to remove the elevated section of this roadway (near the proposed Lechmere and Washington Street stations) and replace it with an at-grade roadway. | Reduced capacity could increase traffic congestion and depress land values, however this effect could be offset by increased transit ridership and improved connectivity between Union Square and the Brickbottom District. | Currently in Planning |
| 7. Grand Junction Rail with Trail | Non-motorized north-south bicycle and pedestrian connection between Boston, MIT, several Cambridge neighborhoods, and Somerville. Would connect to parklands in NorthPoint via the street network. Potential to connect to the proposed Community Path in Somerville. | Could increase bicycle and pedestrian access to station. | Proposed |
| 8. Urban Ring Project | Three-phased, circumferential transit improvement project that would connect to existing radial transit lines to create shorter transit trips and fewer transfers in the project study area. | If implemented, could increase ridership potential and development in the vicinity of the station. | Currently on-hold due to funding constraints |
| **Washington Street Station Area:** | | | |
| 9. Brickbottom and Inner Belt Districts, Somerville | Ongoing planning study by the City of Somerville to explore redevelopment of low-density commercial and industrial land in Brickbottom and Inner Belt Districts as mixed-use and TOD. Could include a 20,000-seat Major League Soccer stadium. | Project would substantially alter the character of the area and increase residential and employment densities near the station. Stadium would create periodic peak demands on the transit system. | Proposed |
| 10. Cobble Hill, Somerville | Ongoing planning study by the City to explore redevelopment of land surrounding a 400-unit senior housing complex on Washington Street. | Likely redevelopment would be higher density, mixed use. | Proposed` |

## Table 6.15-2 Proposed and Reasonably Foreseeable Projects in the Project Corridor (continued)

| Project Name and/or Location[1] | Description | Effects | Status |
|---|---|---|---|
| **Gilman Square Station Area:** | | | |
| 11. Homan's Bldg (350 Medford Street), Somerville | Recommendation in City-sponsored study to redevelop this City-owned, 56,000-sq. ft. industrial building for artist's live/work/study. | Partial acquisition of parking lot and attached loading dock is necessary for the construction of the Gilman Square Station. Historic building would need to be acquired to construct redevelopment by others (likely TOD). | Proposed |
| 12. Walnut Street, Somerville | Recognition by City planners of potential for existing auto-body shops to be redeveloped as residential uses. | Unknown. | Proposed |
| **Lowell Street Station Area:** | | | |
| 13. MaxPac Development, Somerville | Private plans to raze two vacant industrial buildings at 56 and 61 Clyde Street and construct 199 residential units on this 5.49-acre site. | Project would increase residential density near the station. | Planned |
| **College Avenue Station Area:** | | | |
| 14. Boston Avenue between Fitchburg Branch & Harvard Street, Medford | Tufts University concept to construct an Integrated Lab Complex and several other new structures by infill and redevelopment. | Redevelopment would increase development density near the station. | Proposed |
| **Union Square Station Area:** | | | |
| 15. Somerville Avenue and Washington Street, Somerville | Effort by the City to re-zone streets as a Corridor Commercial District. | Rezoning would allow for increased density near the station. | Planned |
| 16. Old Public Safety Building (228 Washington Street), Somerville | Designation by City as a Priority Development Site (PDS). Anticipated redevelopment as high-density commercial with some residential. | Higher density redevelopment, especially office, would increase ridership potential. | Proposed |
| 17. Kiley Barrel Site (226 Somerville Avenue), Somerville | Designation by City as PDS. Anticipated redevelopment as high-density commercial with some residential. | Higher density redevelopment, especially office, would increase ridership potential. | Proposed |
| 18. Boynton Yards (10-acre site abutting west side of Fitchburg Line), Somerville | Ongoing Master Planning effort by the City to explore redevelopment of industrial area as high density residential, commercial, and laboratory uses with ground floor retail. | Higher density redevelopment, especially office, would increase ridership potential. | Proposed |
| 19. Citizens Bank Block (Bow Street between Stone and Warren), Somerville | 2003 Union Square Master Plan recommendation to redevelop as mixed retail, office and residential. | Higher density, redevelopment, especially office, would increase ridership potential. | Proposed |
| 20. South side of Somerville Avenue between Prospect Street and Webster Avenue, Somerville | 2003 Union Square Master Plan recommendation to redevelop as mixed retail, office and residential uses. | Higher density redevelopment, especially office, would increase ridership potential. | Proposed |
| 21. Prospect Street Corridor, Somerville | 2003 Union Square Master Plan recommendation to redevelop as TOD. | Higher density redevelopment, especially office, would increase ridership potential. | Proposed |
| 22. Somerville Avenue and Washington Street east and west of Union Square core | 2003 Union Square Master Plan recommendation for infill development. | Higher density redevelopment, especially office, would increase ridership potential. | Proposed |
| 23. Old Bow Street Police Station (50 Bow Street), Old Union Square Fire Station/SCAT Building, and Recreation Commission Building | 2003 Union Square Master Plan recommendations for re-use as office, retail, housing. | Higher density redevelopment, especially office, would increase ridership potential. | Proposed |

**Table 6.15-2 Proposed and Reasonably Foreseeable Projects in the Project Corridor (continued)**

| Project Name and/or Location[1] | Description | Effects | Status |
|---|---|---|---|
| **General Station Area:** | | | |
| 24. Somerville Community Path | Multi-use path connecting the Minuteman Path to the relocated Lechmere Station area, and other multi-use paths. | Higher bicycle and pedestrian access to the station sites could increase ridership potential. | Proposed |
| 25. MBTA Assembly Square Orange Line | A new Orange Line station between the MBTA Wellington and Sullivan Square stations to provide regional transit access and an alternative to auto traffic. | Project would increase ridership near the new MBTA Orange Line Assembly Square Station. | Proposed |
| 26. Assembly Square Development | The Assembly Square redevelopment district in Somerville is a proposed large-scale, mixed use redevelopment project of 2,100 residential units, more than 2.75 million square feet of retail and office space, and a 200-room hotel. | Project would increase residential density near the new MBTA Orange Line Assembly Square Station. | Proposed |

1 See Figure 6.15-1 for corresponding project locations.

The maintenance and storage facility is compatible with much of the existing industrial land uses along this segment of the rail corridor. However, its development character and impacts could affect future non-industrial development opportunities in adjacent areas. The facility would be similar in appearance to the adjacent MBTA Boston Engine Terminal and other MBTA maintenance facilities serving the Green Line (*e.g.*, Riverside and Reservoir), emit noise occasionally from passenger rail cars entering and leaving the car storage area, and generate truck and automobile traffic in the area. To encourage planned mixed use development near the nearby Washington Street Station and in the Inner Belt area, consistent with City of Somerville planning policies for the area, mitigation measures could be necessary. The design of an aesthetic building facade, the enabling of potential air rights development (perhaps through zoning amendments), and dense screening landscaping could be necessary to create a more compatible facility with future non-industrial land uses.

Although the addition of transit does not directly cause development to occur, plans and policies that provide incentives for new development to be located near transit stations can influence where development takes place and the form of the development. These policies and the presence of a transit system can also have an indirect positive effect on property values near station sites, as has been demonstrated in other cities with transit systems.

## Transit-oriented Development

TOD is generally defined as more concentrated development patterns, and features a mix of uses, moderate to high-density development, good pedestrian access to transit, and less parking. The City of Somerville is developing a TOD ordinance that is expected to be enacted if the Green Line Extension project is built. As with the

No-Build Alternative, development in the project study area, whether auto-oriented or TOD, would be based on market demands.

Pursuant to the policy, if adopted, TOD would be expected in certain station areas. The increased mobility and accessibility that the Green Line Extension would provide would also increase the desirability and value of land near the stations, thereby attracting new real estate investment nearby. The project's primary indirect effect would be to alter development near the stations, bringing higher densities than presently planned or could otherwise be developed in these areas.

These land use effects could take the form of TOD or transit-supportive development. Transit-supportive development includes land uses such as office space and multi-story residential buildings near transit stations but includes ample parking for personal automobile use. Office uses generate more transit riders per square foot of space than any other land use. In comparison to transit-supportive development, TOD is more intensive and deliberately planned to integrate with transit and generally includes pedestrian-oriented moderate to high-density mixed uses and reduced parking.

The Green Line Extension project would focus growth into patterns that would increase the number of viable travel options available to corridor residents and employees, including transit, walking, and bicycling. As an additional benefit, compact TOD reduces the cost of providing utilities, facilities, and services to new residential and commercial developments.

### TOD Potential

The Proposed Action is likely to decrease low intensity commercial and light industrial uses in the project study area and increase mixed-use, high density TOD. The potential for TOD differs at each station site. Factors that could spur TOD, beyond the addition of a transit station, include available and vacant land or buildings, adoption of TOD zoning and policies, other real estate investment in the area, and market demand for new and additional floor space.

Of the seven station sites being considered, only one, the relocated Lechmere Station site, is in an area that can be characterized as already having TOD. Three stations with high potential for TOD are Lechmere, Washington Street, and Union Square. Two station sites (Gilman Square and Ball Square) have moderate potential for TOD, and two (Lowell Street and College Avenue) have low potential due to a lack of available developable land. Those stations with moderate potential have strong public planning support for TOD and in some cases have redevelopment plans for the future. Table 6.15-3 summarizes the TOD potential for each station site.

**Table 6.15-3 TOD Potential at Proposed Station Sites**

| | TOD Potential | | | |
|---|---|---|---|---|
| **Station** | **High** | **Moderate** | **Low** | **Comments** |
| Lechmere, Cambridge (relocated) | X | | | Existing and planned future high density, mixed-use development is transit-oriented. Much vacant land exists in the NorthPoint Planned Unit Development zone. Surrounding area is already TOD. |
| Washington Street, Somerville | X | | | City plans that are under development for Brickbottom and Inner Belt districts are transit-oriented. The area has much vacant and underused land. |
| Gilman Square, Somerville | | X | | The City could redevelop its adjacent parcel for high-density, mixed uses and include cross-track air rights development. |
| Lowell Street, Somerville | | | X | Planned housing development is transit supportive but not mixed-use TOD. No other space is available for TOD. |
| Ball Square, Medford/Somerville | | X | | TOD would require redevelopment of occupied parcels and/or air rights development. Signs of increased activity and projected economic vitality could support redevelopment. |
| College Avenue, Medford | | | X | Tufts University controls most nearby land. TOD potential would require redevelopment of institutional properties to more public uses. Tufts could redevelop some of its properties to higher density and has considered air-rights development in its most recent Master Plan. |
| Union Square, Somerville | X | | | City plans for Union Square and Boynton Yards and related zoning initiatives promote TOD. |
| **Total** | **3** | **2** | **2** | |

## Property Values

Changes in property values that result from construction of a rail transit system are also considered indirect effects. Research based on rail transit systems in U.S. cities has shown that residential property values can increase close to a transit station (Table 6.15-4). While most studies of rail transit's impact on real estate value show increases, they cannot explicitly isolate transit benefits from other market forces.

A case study of potential impacts of commuter rail service on residential property values in the Boston metropolitan area, *Evaluation of the Accessibility Effects and Proximity Related Externalities of Commuter Rail Service,*[24] seems to support these national trends, although the study considered commuter rail, not rapid or light rail transit. The study compared the sales prices in five communities (Ipswich, Needham, Norfolk, Acton, and Winchester) of single family homes generally located within a one-half mile distance of a commuter rail station with the sales prices of similarly assessed properties located one mile or more from the station. The results indicated an average increase in sales price of 5.5 percent for the five communities, although the results for individual communities and properties varied. The study concluded

24 Armstrong, Robert J. *Evaluation of the Accessibility Effects and Proximity Related Externalities of Commuter Rail Service*, Massachusetts Institute of Technology Master's Thesis, September 1997. Available at: http://dspace.mit.edu/bitstream/handle/1721.1/43520/38219997.pdf

that there is a statistically positive effect on property values associated with increased accessibility in communities with commuter rail service.

### Table 6.15-4 Rail System Benefits on Real Estate Values

| Rail System | Rail Technology | Increase in Home Sales Price for Every 100 Feet Closer to Station |
|---|---|---|
| BART - San Francisco[1] | Rapid Transit | $1,578 |
| MTA - New York City[1] | Rapid Transit | $2,300 |
| San Diego[2] | Light Rail | $83 |
| San Jose[2] | Light Rail | $60 |
| MAX - Portland[3] | Light Rail | $202 |
| METRO - Washington, D.C.[4] | Rapid Transit | $0.23 * *increase in per square foot* |

Sources:

1 Lewis-Workman S. and D. Brod, "Measuring the neighborhood benefits of rail transit accessibility," *Transportation Research Record,* 1576: 147-153, 1997.

2 Landis, J., R. Cervero, S. Guhathukurta, D. Loutzenheiser, and M. Zhang, *Rail transit investments, real estate values, and land use change: A comparative analysis of five California rail transit systems,* Monograph 48, Institute of Urban and Regional Studies, University of California at Berkeley, 1995.

3 Al-Mosaind, M.A., K.J. Dueker, and J.G. Strathman, *Light rail transit stations and property values: a hedonic price approach,* Portland, Oregon Center for Urban Studies, Preprint, Transportation Research Board 72nd Annual Meeting, 1993.

4 United States Department of Transportation, Federal Transit Administration, *Transit benefits 2000 working papers: a public choice policy analysis,* 2000.

Value increases near a transit station are realized in real estate sales prices or rents. For residential properties, these increases probably reflect better access to the transit system and associated reductions in vehicle costs. For commercial properties, transit proximity potentially broadens the customer base, increases foot traffic near the business, and contributes to employee accessibility.

In some cases, transit has had a negative effect on real estate values due to what are often called "nuisance" effects—noise, unsightly infrastructure, transit-associated parking lots, and increased bus traffic. These factors can reduce the desirability of properties near the station or railroad corridor. However, such an effect is unlikely with the project, given its proposed location in an existing commuter railroad right-of-way. Such nuisance effects would likely occur in areas where property value is attributable to factors such as isolation and other aesthetic characteristics. If the transit system does not provide travel-time savings or accessibility benefits, the system would likely depress values than increase them. Because the Green Line Extension project is forecast to result in travel-time savings and passes through developed areas along an existing active rail corridor, the likelihood of negative effects on property values in the project study area is minimal.

Housing affordability has been an ongoing concern in the project study area and throughout the project region. The region has many characteristics that make it attractive and expensive: dense, walkable cities and squares; a vibrant economy and proximity to jobs in downtown Boston and Cambridge's Kendall Square; a high concentration of universities and institutions; and its networks of parks and waterways.

Housing prices in the project study area have increased drastically over the last 20 years. The extension of the MBTA Red Line to Davis Square in 1984 made an already desirable location even more desirable and increased real estate values in the neighborhood, including Ball Square. Student demand for housing near Tufts University has helped to keep rents and housing prices high near College Avenue. The NorthPoint development is geared toward high-end residential. The areas with the greatest potential for transit-related price increases are the areas with the greatest potential for high-end redevelopment: Union Square, with the potential redevelopment of Boynton Yards, and Washington Street, with the potential redevelopment of the Brickbottom and Inner Belt industrial areas. To avoid potential displacement of current residents and middle-income individuals and families due to gentrification, the cities should make housing affordability a central theme in the planning for these areas.

## Indirect Effects at Proposed Station Sites

This section describes the potential indirect effects on land use within a ½-mile radius of each proposed station site. This represents the maximum distance most riders are willing to walk. If TOD were to be approved, it would likely be sited within ¼-mile from a station (Figures 5.2-2 through 5.2-8). MassDOT has hosted land use workshops with the affected communities to further identify community needs and issues regarding land use and redevelopment.

Some of the land acquired for station construction would remain largely vacant when the Green Line Extension project is complete, as the new stations would not occupy all of the acquired area. This excess land could be sold for redevelopment or applied towards other local needs and uses.

## Relocated Lechmere Station, Cambridge

Most of the underused land near the proposed relocated Lechmere Station is part of the NorthPoint development project, and other planned projects as described in Section 5.2.4, *Land Use Plans*. Full build-out of these developments would be made more attractive by construction of the Green Line Extension, which would make the area more accessible to a larger region. The site of the existing Lechmere Station, when demolished for this project, would be available for redevelopment although no specific plans have been made at this time.

Additional land use impacts in the station area are uncertain, as there are few other vacant sites available for development. However, the relocated Lechmere Station and the proposed future developments are likely to increase land values in the area, making existing underused parcels attractive sites for potential redevelopment.

## Washington Street Station and Proposed Maintenance and Storage Facility, Somerville

The proposed Washington Street Station is located in a commercial/industrial area south of Washington Street between Joy Street and Inner Belt Road, with a residential neighborhood to the north. The proposed maintenance and storage facility site is in the same general industrial area, on the opposite side of the existing right-of-way from Washington Street Station and the Brickbottom Artists Building near the MBTA Boston Engine Terminal.

The City of Somerville's new land use planning policies would encourage TOD near stations. This means that existing underused and low intensity industrial parcels near the station sites would tend to be replaced over time with mixed-use higher density uses that are more transit supportive and more consistent with higher land values. The City of Somerville is developing plans that would encourage the conversion of the currently commercial/industrial Brickbottom and Inner Belt districts into mixed-use districts. The redevelopment could include a 20,000-seat soccer stadium for the New England Revolution, a franchise of Major League Soccer. In addition, there is a study to explore redevelopment of land surrounding the Cobble Hill apartments to create a mixed income community. The viability of these plans would be supported by the new station and its improved access to downtown Boston and points north and west.

The station would serve the Brickbottom area, residential neighborhoods north and west of the station, and the Inner Belt area, if it were redeveloped. Pedestrian access would be from the surrounding streets and, if the Inner Belt area is redeveloped, potentially via new pedestrian connections over the railroad tracks. The Brickbottom and Inner Belt areas are also intended to accommodate the alignment of the Community Path along the project study area.

The potential for TOD is high because of the supply of vacant and underused parcels and the city planning policy to encourage dense, mixed-use redevelopment. Air rights development over the proposed maintenance and storage facility, which would be in keeping with the MBTA's desire for a covered facility, should be considered as a way to minimize potential adverse visual, noise and access impacts and to enhance the potential for TOD. Moreover, the aesthetic features of the exterior of the maintenance facility structure should enhance the possibility of quality redevelopment nearby. The proposed storage yard can be designed to accommodate the future NorthPoint Bridge to Inner Belt Road. Air rights development could also be used to create new open space, such as playing fields, which is scarce in the Brickbottom/Inner Belt region. The Brickbottom and Inner Belt areas are also intended to accommodate the alignment of the Community Path along the project study area. Therefore, the site planning and design of the maintenance and storage facility are critical with regard to enhancing positive indirect effects.

## Gilman Square Station, Somerville

The proposed Gilman Square Station is located behind the Somerville City Center, within walking distance of over 18,000 residents, more than any other station in the study area. TOD potential in this location is moderate, as the adjacent, vacant City-owned property (the Homan's building, also known as Reid and Murdock Warehouse, a National-Register eligible property) would need to be demolished and the site redeveloped by the City. The City Center is not available for redevelopment in the foreseeable future; however, air rights development over the tracks is a possibility. The steep embankment on the south side of the station site presents a development opportunity. A development concept spanning the tracks could provide access to the station from both the north and the south sides while providing space for the planned Somerville Community Path. There are no other substantial vacant parcels near the station that could be redeveloped.

## Lowell Street Station, Somerville

The proposed Lowell Street Station is located in a primarily residential area. Two vacant industrial buildings adjacent to the railroad corridor are planned to be demolished for the MaxPac Square residential development. The project includes 199 housing units with below-ground parking and landscaped open space. The development plan was approved by the City before the station site was proposed, and there is no planned direct connection to the station. The TOD potential could be improved by refining the design to take the station into account, and by incorporating mixed uses. There are no other substantial vacant or underused sites near the station, limiting TOD potential.

Access to light rail transit at the Lowell Street Station site would support the proposed MaxPac Square development and could increase the value of homes within walking distance of the station.

## Ball Square Station, Medford/Somerville

The proposed Ball Square Station is located at the southeastern edge of a neighborhood commercial district on Broadway and the southern edge of an area with low-density commercial/light industry on Boston Avenue. TOD would require redevelopment of adjacent, occupied properties and would be enhanced by development of air rights over the proposed station. The area experienced an increase in property values following expansion of the MBTA Red Line to Davis Square in the 1980s and redevelopment of sites along Broadway that were destroyed by a fire in the mid-1990s. Construction of a new station in Ball Square could further increase land values and create additional redevelopment opportunities near the proposed station site.

### College Avenue Station, Medford

The proposed College Avenue Station is surrounded by Tufts University properties. Athletic facilities with associated parking are located to the east; science and technology facilities are located to the south; and the main campus is located to the west. A large, university-owned parking garage with limited public parking and a student center is located immediately west of the proposed station. The area has limited TOD potential beyond the station site, as it is dominated by these institutional uses. However, Tufts could convert some of its parking lots and smaller buildings to higher density uses through redevelopment. Proximity to the 8,500-student main campus of the university represents both strong transit ridership and a potential market for mixed-use air-rights development at the station site.

### Union Square Station, Somerville

The proposed Union Square Station would be located in the existing MBTA Fitchburg Line right-of-way in a cut below the Prospect Street Bridge. Land use impacts of the station in the railroad right-of-way could spur redevelopment of the adjacent 10-acre Boynton Yards as a transit-oriented, mixed-use residential, commercial and research and development district, as proposed by the City. The new station would also support redevelopment of other parcels in Union Square at a higher density, as proposed by the City.

## 6.15.4 Cumulative Effects Overview

The cumulative effects of the Proposed Action were evaluated by analyzing past, present, and reasonably foreseeable future actions and impacts. The analysis of cumulative effects addresses the effects of both the Green Line Extension project and other projects.

### Past Actions

Between 1870 and 1915, the project region experienced major population growth: Cambridge population nearly tripled; Medford population more than quadrupled; and Somerville's population increased six fold. Much of this growth can be attributed to expansion of Boston's growth and influence across the Charles River. Growth rates decreased steadily in subsequent decades and leveled off during the 1990s. More recently, the population decreased in Somerville between 2000 and 2009 by one percent, while it remained approximately stable in Medford and Cambridge (Table 6.15-5).

**Table 6.15-5 Populations of Cambridge, Somerville and Medford (2000 and 2009)**

| Municipality | 2000 | 2009 |
|---|---|---|
| Cambridge | 101,355 | 108,771 |
| Somerville | 77,478 | 76,491 |
| Medford | 55,765 | 55,578 |
| Total | 234,598 | 240,840 |

Source: United States Census Bureau, *Census 2000* and 2009 Population Estimates. Note that the 2000 estimates differ slightly from the estimates by Transportation Analysis Zones (TAZ) provided by MAPC.

Transportation projects such as the construction of the I-93 highway and the Monsignor O'Brien Highway viaduct in the late 1950s, and major transit improvements in the 1970s and 1980s supported a population push into the northwest suburbs. The construction of the MBTA Orange Line extension to Oak Grove (1977), the MBTA Red Line extension to Alewife (1984), and improvements in the commuter rail line through the project study area helped improve accessibility between Boston, Cambridge, and Somerville and indirectly reinforced regional growth and development.

Areas of growth and major change since the 1950s have been concentrated in the eastern portion of the project study area. In the 1960s, the Inner Belt District in Somerville was cleared for a highway that was never built and was subsequently redeveloped for primarily low-density commercial and industrial uses. Since the 1980s, east Cambridge has been substantially transformed with a mix of new uses along the Lechmere Canal, the east Cambridge Waterfront, and more recently in NorthPoint. East Cambridge and the industrial areas of Somerville (Brickbottom, the Inner Belt District, and Boynton Yards) are the only sections of the project study area with large tracts of land potentially available for major redevelopment.

## Present and Reasonably Foreseeable Future Actions

Assuming No-Action, MAPC projects that the population in the project study area within one-half mile of a station would be 87,429 in the year 2030, an approximately nine percent increase from the estimated 2010 population (Table 6.15-6). Employment in 2030 is projected to be 41,242, an approximate 15 percent increase from 2010.

**Table 6.15-6 Projected Population and Employment Within One-Half Mile of Proposed Station Sites (2010 and 2030)**

| | 2010 | 2030 |
|---|---|---|
| Population | 80,285 | 87,429 |
| Employment | 35,712 | 41,242 |

Source: Population and employment forecasts by Transportation Analysis Zone (TAZ) prepared by MAPC, August 2008. Population and employment in the ½ mile radius around each station were calculated by assuming the percent of the population and employment in the radius is proportional to the percent of the TAZ in the radius.

Table 6.15-2 lists the major proposed and reasonably foreseeable future projects in Cambridge, Somerville, and Medford that could contribute to cumulative impacts in the project region. Figure 6.15-1 shows the locations of these proposed projects. These projects are largely concentrated in the eastern half of the study area, where there is more industrial and underused land. A number of these projects have already been identified in the Indirect Effects section; however, they could also contribute to the cumulative effects of the project and are included here. "Planned projects" are those that have received most or all of their permits and approvals. "Proposed projects" are projects that have been discussed or studied but are not yet officially approved.

## 6.15.5 Summary of Cumulative Effects

The cumulative effects of the Proposed Action, when combined with past, present, and reasonably foreseeable future actions, are not anticipated to result in any significant impacts on any environmental resource.

### Land Use

#### Cumulative Effects of the No-Build Alternative

More than 20 major redevelopment projects are planned or proposed in the project study area, and many of them are likely to occur with or without the project. Under the No-Build Alternative there would be fewer opportunities for TOD, and there would likely be greater on-site parking requirements, resulting in lower density redevelopment.

#### Cumulative Effects of the Proposed Action

The Proposed Action is likely to result in higher density redevelopment, more TOD, and lower on-site parking requirements in areas that are within walking distance of the stations. The following station areas have the greatest potential for higher density redevelopment and TOD: relocated Lechmere Station; Washington Street Station; and Union Square Station. Combined with other projects, the Proposed Action would increase the mixed use of land near these station sites.

## Transportation and Traffic

### Cumulative Effects of the No-Build Alternative

Traffic congestion on major arterials has steadily worsened as development has increased in the inner Boston metropolitan area. Projects such as the Somerville Community Path extension and improvements in MBTA bus service would improve the regional transportation network. However, under the No-Build Alternative, growth and redevelopment in the project study area would likely increase traffic and degrade the pedestrian and cycling environment over time.

### Cumulative Effects of the Proposed Action

The Green Line Extension project would provide a new transit option northwest of NorthPoint that would mitigate potential traffic increases from continued growth and redevelopment in the project study area. Combined with the Somerville Community Path extension, the Proposed Action would improve the regional transportation network and reduce regional traffic and congestion.

## Property Values

### Cumulative Effects of the No-Build Alternative

Property values in the project study area are likely to increase over time under the No-Build Alternative, particularly in the areas slated for redevelopment (Union Square and Boynton Yards, the Brickbottom District, and the Inner Belt District). Redevelopment would likely occur more gradually under the No-Build Alternative than under the Proposed Action; however, housing affordability would continue to be an ongoing concern.

### Cumulative Effects of the Proposed Action

Property values are likely to increase in areas within walking distance of the stations comprising the Proposed Action. However, the increases are likely to be modest, as the project study area is already highly desirable, and housing affordability is already a concern. The greatest increases are expected to occur in areas that are planned for major redevelopment: Union Square, Boynton Yards, the Brickbottom District, and the Inner Belt District. Public policy to preserve affordability for moderate-income residents and small businesses should be implemented to mitigate transit-related increases in land values.

## Economy

### Cumulative Effects of the No-Build Alternative

The regional economy has undergone a gradual transition from one based on industry and trade to one based on services, knowledge-based industries, life sciences, and technology. More recently, public policy has also highlighted the importance of the arts-based economy in the state and the region. This transition would likely continue under the No-Build Alternative. However, with growth-related increases in traffic and congestion, some businesses in these growth industries could choose to locate outside the project study area.

### Cumulative Effects of the Proposed Action

Continued transition away from the industrial and trade sectors toward the services, knowledge-based industries, life sciences, technology, and the arts is anticipated and is supported by public policy. Planned and proposed projects that would expand employment centers in the study area (redevelopments in east Cambridge, Brickbottom and Inner Belt districts, Union Square and Boynton Yards) would support this trend and are more likely to proceed under the Proposed Action.

## Neighborhoods

### Cumulative Effects of the No-Build Alternative

Redevelopment of underused land in the project study area has been occurring at a fairly rapid pace, affecting the character of some of the local neighborhoods. Redevelopment in east Cambridge has transformed Lechmere Canal, the east Cambridge Waterfront, and more recently, the NorthPoint area into vibrant mixed-use districts. Proposed redevelopment in the Inner Belt and Brickbottom districts and Boynton Yards would follow this trend under the No-Build Alternative.

### Cumulative Effects of the Proposed Action

Redevelopment of underused land in the project study area would be enhanced by the addition of the new and improved transit alternative comprising the Proposed Action. The greatest changes would likely occur in the Brickbottom and Inner Belt districts and in Boynton Yards, where planning is underway for potential redevelopment of these lower rent, commercial/industrial neighborhoods as mixed-use employment centers. Public policy to preserve affordability for moderate-income residents and small businesses should be implemented to minimize impacts of redevelopment on existing neighborhoods.

## Environmental Justice

### Cumulative Effects of the No-Build Alternative

The project study area includes ethnically and economically diverse neighborhoods, particularly in the eastern end. Housing affordability in these neighborhoods and throughout the project study area has been an ongoing concern and would continue to be a concern under the No-Build Alternative.

### Cumulative Effects of the Proposed Action

Environmental justice populations would benefit from the addition of a reliable transit alternative. The Proposed Action would provide more opportunities to live and work in places throughout the region. However, increases in land values near new stations, particularly around Washington Street and Union Square, could impact small businesses and limit affordable housing opportunities. Public policy to help preserve small businesses and maintain housing affordability should be implemented to help maintain diverse communities in the project study area. Because the Proposed Action would not result in any significant environmental effects (after mitigation), there would be no disproportionate adverse impact to environmental justice populations due to the cumulative effects of the Proposed Action.

## Historic Resources

### Cumulative Effects of the No-Build Alternative

Historic resources are located throughout the project study area but particularly in Union Square, which has a large concentration of older and historic buildings. Efforts to identify, protect, and preserve these resources would continue under the No-Build Alternative.

### Cumulative Effects of the Proposed Action

The Proposed Action could stimulate redevelopment of historic resources at a faster pace than the No-Build Alternative, particularly in Union Square. Local ordinances and local public policy are recommended for the Cities of Cambridge, Somerville and Medford to protect historic resources.

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# 7

# Project and Mitigation Commitments

## 7.1 Introduction

This chapter presents MassDOT's proposed mitigation program to address adverse environmental impacts associated with construction and operation of the proposed Green Line Extension project.

## 7.2 Project Benefits

The Proposed Action is expected to generate 49,000 new daily boardings and alightings at the project's seven stations and generate new systemwide transit ridership of 7,500 daily linked transit trips and a reduction of 25,728 VMT per day (projected to the year 2030). The increased transit access and ridership would improve corridor mobility, improve traffic conditions, improve regional air quality, increase services to disabled and environmental justice populations, and support future smart growth initiatives and sustainable development.

## 7.3 Project and Mitigation Measures

This section summarizes project and mitigation measures proposed to prevent or reduce environmental impacts of the Proposed Action. Potential permanent and construction impacts resulting from constructing the Proposed Action would be mitigated to the extent practicable, as described in this chapter.

Transit projects such as the Green Line Extension project are required to be evaluated for potential impacts of the Proposed Action using standard analytical measures and methods approved by the FTA and relevant state agencies, as was described in Chapter 6, *Environmental Consequences*. Mitigation measures are typically developed based on these standard methods and legal requirements, and are the basis for the project's mitigation commitments.

Specific mitigation elements that are subject to FTA regulations and guidelines include noise, vibration, and land acquisition (which is governed by the Uniform Act[1]). Proposed mitigation measures for the Green Line Extension project, as summarized in Tables 7.4-1 and 7.5-1, address impacts to or from:

- Land Use
- Socioeconomics
- Traffic and Transportation Systems
- Noise
- Vibration
- Water Quality/Stormwater
- Cultural Resources
- Visual Environment
- Section 4(f) Resources
- Hazardous Materials
- Air Quality
- Construction

These mitigation elements are described in detail in this chapter.

### 7.3.1 Land Use

As a project commitment, MassDOT would work with the community in the area of the future Mystic Valley/Route 16 to consider land use and station design elements. As a project commitment, MassDOT has agreed to complete the final design for the proposed Somerville Community Path extension between Lowell Street and the Inner Belt area and work with the City of Somerville to identify opportunities for state and Federal funding for construction of Community Path.

### 7.3.2 Socioeconomics

The Uniform Act stipulates how the value of property acquisition must be established, and requires FTA to compensate land owners for the fair market value of their property. If Federal funding for the project is secured, MassDOT is required to follow the procedures established by the Uniform Act for any property acquisition and job relocations.

1 United States Department of Transportation. 49 CFR Part 24, *Uniform Relocation Assistance and Real Property Acquisition Policies Act of 1970, as amended*. Public Law 91-646, January 2, 1971. Available at: http://www.fhwa.dot.gov/realestate/ua/uraguide3805.pdf

### 7.3.3 Traffic and Transportation Systems

By 2015, regardless of the Green Line Extension project, traffic signal timing and phasing would be inadequate to accommodate the projected traffic demands at a number of locations. The Proposed Action would include optimizing traffic signal timing and phasing to maximize the efficiency of signalized intersections in both 2015 and 2030. Specific mitigation measures at various intersections are discussed in this section. MassDOT would work with the cities and applicable emergency personnel to ensure that appropriate safety measures are incorporated throughout the design and construction.

#### Pedestrian Mitigation

Mitigation measures are necessary to accommodate safe and efficient pedestrian access to the proposed Green Line Extension project stations. Mitigation measures to offset impacts to pedestrians include:

- Install crosswalks and appropriate warning signage;
- Increase pedestrian walk time;
- Improve existing crosswalk markings and repairing existing pedestrian signal equipment;
- Signalize side street crossings and increase walk time on main streets; and
- Conduct signal warrant analyses and, if warranted, install signals.
- Pedestrian mitigation measures are proposed at 29 locations (Table 7.3-1). These locations were identified for mitigation as part of the regional pedestrian analysis.
- Traffic Mitigation

In addition to improved signal phasing and timing, two intersections would require physical mitigation to offset adverse impacts caused by the Proposed Action's increased vehicular traffic.

#### Boston Avenue at Winthrop Street

To mitigate impacts caused by the Proposed Action, Boston Avenue northbound (which currently provides all movements from a single lane) would be striped to provide an exclusive left-turn lane and a shared through/right-turn lane. Signal timing and phasing changes would also be required. This improvement would require removing approximately 12 parking spaces along Boston Avenue. It is anticipated that operations would improve at this intersection from LOS E to LOS D in 2030 evening peak hour as a result of this mitigation.

Table 7.3-1 Proposed Pedestrian Mitigation Measures

| Intersection | Proposed Mitigation |
|---|---|
| Boston Avenue at North Street | Upgrade pedestrian signal heads and increase pedestrian Walk/flashing Don't Walk time |
| Boston Avenue at Winthrop Street | Restripe crosswalk markings |
| Boston Avenue between Winthrop Street and College Avenue (mid-block) | Install warning signage for mid-block crossing |
| Boston Avenue at Harvard Street | Restripe crosswalk markings |
| Powder House Rotary | Increase pedestrian Walk/flashing Don't Walk time |
| Boston Avenue at Broadway | Install crosswalk across Broadway and incorporate into new traffic signal phasing |
| College Avenue between Boston Street and Frederick Avenue (mid-block) | Conduct signal warrant analysis and install pedestrian signal for crossing |
| College Avenue at George Street | Restripe crosswalk markings and install wheelchair ramps |
| Main Street at George Street | Install crosswalk across George Street and install wheelchair ramps |
| Main Street at Mystic Valley Parkway Ramps | Restripe crosswalk markings |
| Main Street at Harvard Street | Restripe crosswalk markings |
| Main Street at Mystic Avenue | Restripe crosswalk markings |
| Medford Street at Broadway | Increase pedestrian Walk/flashing Don't Walk time |
| Medford Street at Lowell Street | Install crosswalk across Medford Street (south) |
| Medford Street at Central Street | Repair pedestrian signal head and increase pedestrian Walk/flashing Don't Walk time |
| Medford Street at School Street | Increase pedestrian Walk/flashing Don't Walk time |
| Medford Street at Pearl Street | Install new traffic signal with signalized crossing of Medford Street |
| Medford Street at Walnut Street | Increase pedestrian Walk/flashing Don't Walk time |
| Medford Street at Highland Avenue | Signalize side street crossings.<br>Increase pedestrian Walk/flashing Don't Walk time |
| Highland Avenue at Lowell Street | Increase pedestrian Walk/flashing Don't Walk time |
| Highland Avenue at Central Street | Increase pedestrian Walk/flashing Don't Walk time |
| Washington Street at McGrath Highway | Incorporate pedestrian crossings into traffic signal phasing and install appropriate equipment |
| Washington Street at Tufts Street | Install new traffic signal with signalized crossing of Washington Street |
| Washington Street at Inner Belt Road | Increase pedestrian Walk/flashing Don't Walk time |
| Medford Street at Somerville Avenue /McGrath Highway | Incorporate pedestrian crossings into traffic signal phasing and install appropriate equipment |
| Washington Street at Somerville Avenue/Prospect Street | Increase pedestrian Walk/flashing Don't Walk time |
| Washington Street at Somerville Avenue/Webster Street | Increase pedestrian Walk/flashing Don't Walk time |
| Washington Street at Kirkland Street | Increase pedestrian Walk/flashing Don't Walk time |
| Prospect Street at Webster Street | Install a crosswalk across Prospect Street (north). Increase pedestrian Walk/flashing Don't Walk time. Incorporate unsignalized crossings into traffic signal and install appropriate equipment. |

While evening peak hour level of service improves, morning peak hour operations would remain at LOS E under the 2030 condition. A summary of traffic operations at this location with and without mitigation is presented in Table 7.3-2.

## Boston Avenue at College Avenue

To mitigate impacts caused by the Proposed Action, College Avenue westbound would be widened to provide an exclusive right-turn lane to Boston Avenue. To accommodate this improvement, the College Avenue Bridge over the railroad tracks would be widened as part of the bridge work. Signal timing and phasing changes would also be required. Changes can be made without additional construction impacts. It is anticipated that operations would improve at this intersection from LOS E to LOS D during both the morning and evening peak hours in 2030 with this mitigation. A summary of traffic operations at this location with and without mitigation is presented in Table 7.3-2.

### Table 7.3-2 Signalized Intersection Traffic Operations – with Mitigation

| | Proposed Action (2015) | | | | | | Proposed Action with Mitigation (2015) | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Morning Peak Hour | | | Evening Peak Hour | | | Morning Peak Hour | | | Evening Peak Hour | | |
| Intersection | V/C[1] | Delay[2] | LOS[3] | V/C | Delay | LOS | V/C | Delay | LOS | V/C | Delay | LOS |
| Boston Avenue at Winthrop Street | 1.07 | 59 | E | 1.07 | 71 | E | 1.10 | 64 | E | 0.84 | 39 | D |
| Boston Avenue at College Avenue | 0.97 | 70 | E | 0.92 | 57 | E | 0.91 | 48 | D | 0.81 | 38 | D |
| | Proposed Action (2030) | | | | | | Proposed Action with Mitigation (2030) | | | | | |
| | Morning Peak Hour | | | Evening Peak Hour | | | Morning Peak Hour | | | Evening Peak Hour | | |
| Intersection | V/C | Delay | LOS | V/C | Delay | LOS | V/C | Delay | LOS | V/C | Delay | LOS |
| Boston Avenue at Winthrop Street | 1.06 | 64 | E | 1.10 | 76 | E | 1.11 | 70 | E | 0.92 | 44 | D |
| Boston Avenue at College Avenue | 1.00 | 71 | E | 0.91 | 57 | E | 0.94 | 53 | D | 0.82 | 39 | D |

1 Volume-to-capacity ratio
2 Average delay expressed in seconds per vehicle
3 Level-of-Service

## Pedestrian Accommodations at Traffic Signals

To accommodate Proposed Action-related pedestrian traffic, signal timing and/or phasing adjustments are proposed at the following locations. These improvements have been incorporated into the Proposed Action traffic analyses for 2015 and 2030 and are reflected in Tables 6.5-6 and 6.5-7 presented in Section 6.5, *Traffic and Transportation Systems*.

### Washington Street at McGrath Highway

A new signal phasing sequence is proposed at this intersection to incorporate pedestrian accommodations into the traffic signal (although this is a signalized intersection, pedestrian crossings at this location are not part of the traffic signal). This change would likely require new equipment and new wiring between traffic signal heads and the control cabinet.

#### Prospect Street at Somerville Avenue

Pedestrian crossing times would be increased at this location, which would cause an adverse impact to overall vehicular traffic operations (*i.e.*, delay) during at least one peak hour. There is no opportunity at this location to increase capacity by adding lanes or changing lane allocation. However, traffic and pedestrian signal timings could be further adjusted to balance the needs of pedestrians and motorists. This proposed mitigation would be in place until the City of Somerville moves forward with plans to reconfigure the roadway network in the Union Square area (as described in Section 6.5, *Traffic and Transportation Systems*). At that time, the City would implement different changes, which are also expected to be effective in managing pedestrian, bicycle, and vehicle movements through this intersection.

#### Washington Street at Somerville Avenue/ Webster Street

Pedestrian crossing times would be increased at this location, which would cause an adverse impact to overall vehicular traffic operations (*i.e.*, delay) during at least one peak hour. There is no opportunity at this location to increase capacity by adding lanes or changing lane allocation. However, traffic and pedestrian signal timings could be further adjusted to balance the needs of pedestrians and motorists. This proposed mitigation would be in place until the City of Somerville moves forward with plans to reconfigure the roadway network in the Union Square area. At that time, the City would implement different changes, which are also expected to be effective in managing pedestrian, bicycle, and vehicle movements through this intersection.

### Pickup/Drop-off Locations

Three of the proposed stations, at Washington Street, Gilman Square, and Ball Square, include pickup/drop-off accommodations that affect adjacent traffic signals or require new traffic signals. To accommodate the proposed driveway and pickup/drop-off activities at these stations, mitigation is recommended at the following locations:

- Washington Street at Tufts Street (Washington Street Station);
- Medford Street at Pearl Street/station exit driveway (Gilman Square Station);
- Medford Street at School Street (Gilman Square Station); and
- Broadway/Boston Avenue at station exit/Rogers Avenue (Ball Square Station).

All of the locations impacted by pickup/drop-off activities are projected to operate at acceptable levels of service with the recommended improvements.

#### Washington Street at Tufts Street

The proposed station layout for Washington Street includes a small parking area immediately adjacent to Washington Street Station on the east side. The driveway to this pickup/drop-off area would be located along Washington Street across from Tufts Street. The new four-way intersection would be controlled by a traffic signal. The proposed layout for Washington Street Station is illustrated in Figure 4.4-5. To accommodate the new traffic signal, Washington Street would be widened to four lanes between McGrath Highway and Tufts Street. The sidewalk on the north side of Washington Street would be reconstructed.

As shown in Table 7.3-3, the intersection of Washington Street and Tufts Street, which currently operates at an unacceptable LOS F, would operate at an acceptable level of service with the recommended improvements.

### Table 7.3-3 Pickup/Drop-off Traffic Operations – Washington Street Station (2030)

| | | Proposed Action | | | | | | Proposed Action with Mitigation | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Morning Peak Hour | | | Evening Peak Hour | | | Morning Peak Hour | | | Evening Peak Hour | | |
| Intersection | Critical Movement | V/C[1] | Delay[2] | LOS[3] | V/C | Delay | LOS | V/C | Delay | LOS | V/C | Delay | LOS |
| Washington Street at Tufts Street (unsignalized) | Tufts Street | >1.2 | >60 | F | >1.2 | >60 | F | N/A | | | | | |
| Washington Street at Tufts Street (signalized) | N/A | N/A | | | | | | 0.70 | 14 | B | 0.66 | 9 | B |

N/A = not applicable
1 Volume-to-capacity ratio
2 Average delay expressed in seconds per vehicle
3 Level-of-Service

<u>Gilman Square - Medford Street at Pearl Street</u>

This unsignalized intersection processes a high amount of traffic, currently operates at LOS F during the morning peak hour, and would degrade to LOS F during the evening peak hour by 2030, with or without the project in place. The number of pedestrians crossing Medford Street would increase and would require a crosswalk to accommodate pedestrian demands.

The proposed station layout at Gilman Square includes a one-way pickup/drop-off loop. The entrance to the loop would be located along Medford Street, across from its intersection with Pearl Street. The exit driveway would intersect Medford Street just south of Pearl Street and allow for a right-turn only exit to Medford Street. This configuration and access limitation is necessitated by the historic property immediately adjacent to the station. The proposed layout for Gilman Square Station is illustrated in Figure 4.4-7. Recommended improvements to accommodate the driveway layout include:

- Install fully-actuated traffic signal at the intersection of Medford Street at Pearl Street and coordinate with the Medford Street at School Street signal;
- Provide left-turn lane to Pearl Street for the Medford Street southeast approach;
- Optimize signal timings at the intersection of Medford Street at School Street; and
- Install crosswalks on the south (Medford Street) and east (Pearl Street) approaches to the intersection.

As shown in Table 7.3-4, project study area intersections in the vicinity of the Gilman Square Station would improve when compared to the Proposed Action. It should be noted that the Proposed Action results at Medford Street and School Street already include signal timing improvements that were developed as part of the Proposed Action condition. Improvement at this location is substantial when compared to the No-Build Alternative. All three intersections are projected to operate at acceptable levels of service beyond the 2030 design year with the recommended improvements.

## Table 7.3-4 Pickup/Drop-off Traffic Operations – Gilman Square Station (2030)

| | | Proposed Action | | | | | | Proposed Action with Mitigation | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Critical | Morning Peak Hour | | | Evening Peak Hour | | | Morning Peak Hour | | | Evening Peak Hour | | |
| Intersection | Movement | V/C[1] | Delay[2] | LOS[3] | V/C | Delay | LOS | V/C | Delay | LOS | V/C | Delay | LOS |
| Medford Street at School Street (signalized) | N/A | 0.92 | 42 | D | 0.90 | 31 | C | 0.98 | 41 | D | 0.89 | 28 | C |
| Medford Street at station exit driveway (unsignalized) | Medford Street northbound | N/A | | | | | | 0.08 | 7 | A | 0.08 | 7 | A |
| Medford Street at Pearl Street (unsignalized – No-Build) | Pearl Street westbound | >1.2 | >60 | F | 0.93 | 56 | F | N/A | | | | | |
| Medford Street at Pearl Street (signalized – Build with Pickup/Drop-off) | N/A | N/A | | | | | | 0.52 | 16 | B | 0.48 | 19 | B |

N/A = not applicable
1 Volume-to-capacity ratio
2 Average delay expressed in seconds per vehicle
3 Level-of-Service

### Ball Square – Broadway at Boston Avenue/Rogers Avenue/Station Exit

The proposed station layout for Ball Square includes a one-way pickup/drop-off loop. The entrance to the loop would be located along Boston Avenue, just to the north of Broadway. The exit driveway would intersect Boston Avenue/Broadway opposite Rogers Avenue. The proposed layout for Ball Square Station is illustrated in Figure 4.4-11. Recommended improvements to accommodate this driveway layout include modifications to the signal phasing and timing at the intersection of Broadway and Boston Avenue/Rogers Avenue/Station exit.

Table 7.3-5 Pickup/Drop-off Traffic Operations – Ball Square Station (2030)

| | | Proposed Action | | | | | | Proposed Action with Mitigation | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Morning Peak Hour | | | Evening Peak Hour | | | Morning Peak Hour | | | Evening Peak Hour | | |
| Intersection | Critical Movement | V/C[1] | Delay[2] | LOS[3] | V/C | Delay | LOS | V/C | Delay | LOS | V/C | Delay | LOS |
| Broadway/Boston Avenue at station exit driveway (signalized) | N/A | 0.87 | 22 | C | 0.70 | 13 | B | 0.95 | 43 | D | 0.76 | 20 | B |
| Boston Avenue at station entrance driveway (unsignalized) | Boston Avenue southbound | N/A | | | | | | 0.00 | 0 | A | 0.00 | 0 | A |

N/A = not applicable
1 Volume-to-capacity ratio
2 Average delay expressed in seconds per vehicle
3 Level-of-Service

As shown in Table 7.3-5, project study area intersections in the vicinity of the Ball Square Station would continue to operate at acceptable levels of service with the recommended improvements.

## Monsignor O'Brien Highway/Route 28 Reconstruction

As discussed in Section 6 5.2, *Environmental Consequences*, the Full-Build NorthPoint development is assumed to be in place by 2030, the design year for the Green Line Extension project transportation analysis. By 2030, it is also assumed that all mitigation associated with the NorthPoint development would be in place. This includes reconstructing Monsignor O'Brien Highway/Route 28 from Third Street to Museum Way (including the midblock pedestrian crossing west of Land Boulevard) and constructing internal NorthPoint streets as delineated in the NorthPoint special permit.

A number of the mitigation measures associated with NorthPoint are necessary to support the relocation of Lechmere Station across Monsignor O'Brien Highway/Route 28. With the delay of the NorthPoint project, these mitigation measures would be implemented as mitigation for the Green Line Extension project. Specifically, the following measures are proposed, as depicted on Figure 4.4-3:

- Reconstruct Monsignor O'Brien Highway/Route 28 at its intersection with Third Street to restrict westbound left-turns from Monsignor O'Brien Highway/Route 28 to Third Street, provide an upgraded pedestrian crossing, and new signal timing and phasing.
    - Vehicles that turn left onto Third Street today would be accommodated by turning left onto North First Street (one block south) and then turning right onto Cambridge Street.

  - Prior to the completion of NorthPoint construction, buses that turn left onto Third Street today would be accommodated by turning left out of Water Street, right onto North First Street, and right onto Cambridge Street.
  - Upon completion of NorthPoint construction, buses will exit Lechmere Station directly onto North First Street and turn right onto Cambridge Street.
- Reconstruct Monsignor O'Brien Highway/Route 28 at its intersection with Water Street to remove the median and allow eastbound left-turns from Monsignor O'Brien Highway/Route 28 to Water Street. Left turns from Water Street would be allowed prior to construction of NorthPoint and restricted once NorthPoint is complete. A new crosswalk would be provided on the east side of the intersection and the intersection would be signalized.
- Reconstruct Monsignor O'Brien Highway/Route 28 at North First Street and East Street:
  - First Street would be extended through existing Lechmere Station to connect to Monsignor O'Brien Highway/Route 28 creating a new signalized intersection.
  - Eastbound left turns onto North First Street (into the new Station) would be prohibited. This movement would be accommodated at Water Street.
  - Westbound left turns from Monsignor O'Brien Highway/Route 28 to First Street and Cambridge Street would occur at this intersection under the proposed mitigation.
  - East Street would be reconstructed to be a right turn in/right turn out driveway and the median extended along Monsignor O'Brien Highway/Route 28 to prohibit other movements. The existing traffic signal would be removed.
- Reconstruct the intersection of Cambridge Street and First Street, including new signal timing and phasing.
- Reconstruct First Street between Cambridge Street and Monsignor O'Brien Highway/Route 28 to make the roadway one-way eastbound to Monsignor O'Brien Highway/Route 28.

The proposed improvements are necessary to support vehicular traffic and pedestrian crossings associated with the relocation of Lechmere Station.

Installation of the midblock pedestrian crossing south of East Street and improvements at the intersection of Monsignor O'Brien Highway/Route 28 at Land Boulevard/ Charlestown Avenue and at the intersection of Monsignor O'Brien Highway/Route 28 at Museum Way are not proposed as part of the Green Line Extension project, as the project does not impact traffic or pedestrian operations at these locations. It is assumed that the changes proposed at these locations as part of NorthPoint would be completed by the ultimate proponent of the development's completion.

### Parking Enforcement Mitigation

The parking demand analysis completed for the Proposed Action indicated a need to accommodate approximately 180 daily park-and-ride patrons who would drive to the relocated Lechmere Station. The travel demand model estimates that these are regional travelers who would be diverted from other stations (such as Wellington or Alewife) or who currently pass the proposed station location while driving into Boston. The majority of these riders would not switch to Green Line service under the Proposed Action. However, the lack of available long-term parking may encourage some motorists to park on local streets. Increasing parking enforcement or changing local parking restrictions to restrict commuter parking would be effective in reducing neighborhood impacts. MassDOT will work with the affected communities to develop acceptable parking enforcement plans for the areas within one-half mile of the stations in order to limit potential impacts.

### Public Bus Transportation Mitigation

MassDOT will work with the MBTA to evaluate opportunities to improve connections between the new stations and existing bus service.

## 7.3.4 Noise

Noise mitigation is considered depending on the need, feasibility, reasonableness and effectiveness of potential options. FTA guidance states that in considering potential noise impact, severe impacts should be mitigated if at all practical and effective. At the moderate impact level, more discretion should be used, and other project-specific factors should be included in considering mitigation. These factors include the predicted increase over existing noise levels, the types and number of noise-sensitive land uses affected, existing outdoor-to-indoor sound reduction, the effectiveness of mitigation options and the cost-effectiveness of mitigating the noise. However, there is a stronger need for mitigation if a project is proposed in an area currently experiencing high noise levels (Ldn above 65 dBA) from surface transportation sources. This is clearly the case at sensitive receptors along the existing MBTA Fitchburg Line and MBTA Lowell Line where existing Ldn levels range between 65 to 80 dBA. In view of this guidance, mitigation would be provided for the Proposed Action for both moderate and severe noise impacts wherever practical and wherever existing noise levels are above 65 dBA. For receptors with no significant outdoor land use where only interior spaces are sensitive to noise, mitigation would be provided if interior Ldn levels would be above 45 dBA from project sources or single-event maximum noise levels would be above 65 dBA. Mitigation is not required for interior spaces where future noise levels without mitigation would be below 45 Ldn and 65 dBA Lmax.

## Proposed Noise Mitigation

To mitigate noise impact from train operations, noise control can be considered at the source, along the sound path, or at the receiver. Source noise control options, for example, may include special hardware at turnout locations (*e.g.*, by using spring-rail or moveable-point frogs in place of standard rigid frogs), relocating special trackwork away from sensitive areas, and using continuous welded rail. Noise barriers are the most common sound path noise control treatment and can be very effective at reducing noise levels in the community. Noise control at the receiver can also be achieved by using sound insulation treatments at residences and institutional buildings. The mitigation recommendations in this section would be refined further during the design process of the Proposed Action.

Noise barriers have been used to mitigate potential noise impact for numerous transit lines across the United States and internationally. Noise barriers are generally effective means of reducing noise from most transit sources when they break the line-of-sight between the source and the receiver. The height necessary for providing sufficient noise reduction depends on the source height and the distance from the source to the barrier. Effective noise barriers can easily reduce noise levels 10 decibels or more depending on the specific implementation. There are many different materials and designs available for noise barriers, including some made of recycled or other environmentally conscious materials. Figure 7.7-1 shows several possible materials for noise barriers. During final design, illustrations of proposed barriers may be available to the community and the public would have an opportunity to provide input into the specific noise barrier design.

At locations along the alignment where noise impact would occur, noise barriers would be constructed in conjunction with retaining walls or along the right-of-way line. At many noise barrier locations, the tracks are in a cut relative to the surrounding terrain which makes these locations well-suited for blocking the line-of-sight to the trains and reducing noise. Table 7.3-6 presents a summary of proposed noise barrier mitigation including the receptor locations, barrier length, side of tracks, barrier height, noise reduction at representative receptors, and barrier locations along the alignment. Proposed noise barrier locations are shown in Figures 6.7-2 through 6.7-6. Further details on each noise barrier are included in Appendix F, *Noise and Vibration Technical Report*.

For many locations along the Proposed Action, noise barriers are a feasible and effective means of noise mitigation. Most noise barriers would be constructed with an absorptive surface to minimize the potential of sound reflecting off barriers to sensitive locations on the opposite side of the tracks. Typically, the noise barriers would be tall enough to block the line-of-sight to the top of the commuter trains for ground-level receptors

## Table 7.3-6 Summary of Proposed Noise Barrier Mitigation Measures

| Barrier Number | Receptor Locations | Length (feet) | Side of Tracks | Barrier Height (feet) | Noise Reduction (dBA) | Barrier Location |
|---|---|---|---|---|---|---|
| N-1 | Glass Factory Condominiums and Hampton Inn | 1,400 [1] | West [1] | 8 to 10 | 9 to 18 [4] | Two barriers; near track and between tracks |
| N-2 | Brickbottom Artists Building (Northeast Façade) | 1,350 [2] | West [2] | 12 (Medford Inbound Mainline) and 8 (Medford Inbound Yard Lead) | 6 to 11 [4] | Two barriers; Medford Inbound Track – southwest edge of elevated guideway and at grade and Medford Inbound Yard Lead – southwest side of track |
| N-3 | Brickbottom Artists Building (South Façade) | 1,400 [3] | North [3] | 12 | 3 to 11 [4] | Two barriers; Union Square Outbound – northeast side of elevated guideway and at grade and Union Square Inbound – northeast side of elevated guideway |
| N-4 | Alston Street | 300 | West | 7 | 9 | Retaining wall for proposed community path |
| N-5 | Between Cross Street and McGrath Highway (Avon Place) | 500 | East | 7 | 9 | Existing retaining wall |
| N-6 | Between McGrath Highway and Walnut Street (Gilman Street) | 750 | East | 10 | 7 | Existing retaining wall |
| N-7 | Between School Street and Sycamore Street (Richdale Avenue) | 850 | East | 9 | 8 | Existing retaining wall |
| N-8 | Sycamore Street near Richdale Avenue | 200 | East | 7 | 10 | Embankment on right-of-way |
| N-9 | Vernon Street | 750 | East | 10 to 18 | 7 to 8 | Right-of-way |
| N-10 | Nashua Street/ Henderson Street/ Hinckley Street | 1,000 | East | 12 | 9 to 13 | Embankment on right-of-way |
| N-11 | Trum Playground | 100 | East | 8 | 12 | Existing retaining wall |
| N-12 | Cedar Street and Wilson Avenue | 400 | East | 12 | 10 to 13 | Proposed retaining wall |
| N-13 | Between Cedar Street and Broadway (Boston Avenue) | 800 | West | 12 | 7 to 11 | Proposed retaining wall |
| N-14 | Newbern Avenue/ Morton Avenue/ Granville Avenue | 1,200 | East | 18 | 7 to 13 | Proposed retaining wall |
| N-15 | Burget Avenue | 850 | East | 6 | 6 | Proposed retaining wall |
| N-16 | Horace Street | 250 | South | 16 | 7 to 10 | Proposed retaining wall |
| | Walnut Street Center | 600 | North | 10 | 10 | Right-of-way |
| | Total Length (feet) | 12,700 | Total Area (ft²) | 139,450 | Total Cost | $4.2 million |

Source: *Green Line Extension, Noise and Vibration Technical Report*, Prepared by Harris Miller Miller and Hanson, Inc. August 2011.

Proposed noise barrier locations are shown in Figures 6.7-2 through 6.7-6.

1 Noise barrier length includes two segments; one noise barrier on southwest edge of guideway to reduce noise from the Green Line Inbound track and one noise barrier in between the tracks to reduce noise from the Green Line Outbound track.

2 Noise barrier length includes two segments; one noise barrier on southwest side of Medford Inbound Track and one on the southwest side of the Medford Inbound Yard Lead.

3 Noise barrier length includes two segments; one noise barrier on northeast side of Union Square Outbound track and one on northeast side of Union Square Inbound track.

4 Noise reduction includes track vibration isolation for reduction of radiated noise from structure.

At the Glass Factory Condominiums and the Hampton Inn Hotel, noise barriers would be effective; however, there is no exterior land use with frequent human use at these locations. The need to mitigate for interior spaces is similarly assessed based on whether the buildings would already be sufficient to keep future interior noise levels from project sources below 45 Ldn and 65 Lmax (single event train pass-bys). The results of this assessment, presented in Table 7.3-7, show that future interior noise levels without mitigation would be above 45 Ldn and 65 Lmax and, therefore, mitigation is required.

At the Glass Factory Condominiums and the Hampton Inn Hotel northeast façade of the Brickbottom Artists Building, a double-noise barrier system (noise barriers with absorptive surfaces on both the near track and in between the tracks) would be effective in reducing noise from Green Line trains even at upper floor receptors. The barrier between the inbound and outbound tracks would be needed for reducing noise from trains on the far track

At the northeast façade of the Brickbottom Artists Building, two noise barriers would be effective in reducing noise from Green Line trains even at upper floor receptors. One barrier would be located on the southwest edge of the elevated guideway of the Medford Inbound track. One barrier would be along the Medford Inbound Yard Lead which is at-grade.

Table 7.3-7 Future Exterior and Interior Noise Levels at Sound Insulation Candidate Receptors

| | Future Exterior Noise Levels from Project Sources | | | Future Interior Noise Levels from Project Sources Without Mitigation | | |
|---|---|---|---|---|---|---|
| Noise Sensitive Receptor | Day-Night Sound Level (Ldn) | Single-Event Maximum Level (Lmax) | Noise Level Reduction | Day-Night Sound Level (Ldn) | Single-Event Maximum Level (Lmax) | Mitigation Required for Future Interior Noise Levels above 45 Ldn or 65 dBA Lmax |
| Glass Factory Condominiums | 70 | 87 (Green Line) | 27.2 (Green Line) | 46 | 62 (Green Line) | Yes |
| Hampton Inn Hotel | 71 | 88 (Green Line) | 27.6 (Green Line) | 47 | 63 (Green Line) | Yes |
| Pearl Street Apartments | 73 | 87 (Green Line)<br>95 (Commuter) | 24.4 (Green Line)<br>23.7 (Commuter) | 52 | 66 (Green Line)<br>74 (Commuter) | Yes |
| Powderhouse Condominiums | 80 | 90(Green Line)<br>98(Commuter)[3] | 28 (Green Line)[2]<br>28 (Commuter)[2] | 55 | 65 (Green Line)<br>73 (Commuter) | Yes |
| Tufts University Science and Technology Center[1] | 84 (80 Leq) | 89 (Green Line)<br>95 (Commuter) | 27.5 (Green Line)<br>27.2 (Commuter) | 60 (56 Leq) | 64 (Green Line)<br>71 (Commuter) | Yes |
| Outside the Lines Studio[1] | 84 (80 Leq) | 89 (Green Line)<br>95 (Commuter) | 28.6 (Green Line)<br>28.3 (Commuter) | 59 (55 Leq) | 63 (Green Line)<br>70 (Commuter) | Yes |

Source: Harris Miller Miller and Hanson, Inc., *Green Line Extension Noise and Vibration Technical Report*, August 2011.

1 Need for mitigation of interior spaces at institutional land use is assessed based on Ldn.

2 Noise level reduction estimated based on general building construction information.

3 Noise projections include contributions from special track work.

On the south façade of the Brickbottom Artists Building, two noise barriers would be effective in reducing future noise levels from both Green Line trains and commuter trains. The noise barriers include one barrier at-grade along the near Green Line track (outbound to Union Square) and one noise barrier on the elevated guideway along the far Green Line track (inbound from Union Square).

The heights of the noise barriers along the Glass Factory Condominiums, Hampton Inn Hotel and Brickbottom Artists Building are dependent on the specific guideway designs and how close they can be constructed to the trains while not compromising safety requirements (i.e., emergency egress, train clearances, etc.). Assuming the tops of the barriers are effectively four feet from the near rail, barriers would be approximately eight to 12 feet in height.

To reduce the potential for radiated noise from the elevated structure at Glass Factory Condominiums, Hampton Inn Hotel and Brickbottom Artists Building, vibration isolation of the track by means of ballast mats (if ballast and tie track is used) or resilient rail fasteners (if direct fixation track is used) would be included.

At the Pearl Street Apartments, Powderhouse Condominiums, Tufts University Science and Technology Center, and Outside the Lines Studio, noise barriers would not be feasible or effective in mitigating potential impact due to their close proximity to the alignment and upper floor receptors. Sound insulation improvements for these buildings to improve the outdoor-to-indoor level reduction (OILR) have been considered. Substantial improvements in building sound insulation (on the order of 5 to 10 dBA) can often be achieved by adding an extra layer of glazing to windows, by sealing any holes in exterior surfaces that act as sound leaks. In order for sound insulation improvements to be effective, windows and doors must remain closed; therefore, these building improvements would require adequate heating, cooling, and ventilation be provided (if it does not already exist) to allow windows and doors to remain closed.

If the existing noise reduction of these buildings would already be sufficient to keep future interior noise levels from project sources below 45 Ldn and 65 Lmax (single event train pass-bys), then sound insulation improvements would not be necessary. The OILR of representative rooms in these buildings was measured to project future interior noise levels and assess the need for sound insulation mitigation. Interior future noise levels were calculated by subtracting the minimum noise level reduction (NLR) from the exterior noise levels including a three decibel factor of safety.

At the Pearl Street Apartments, Powderhouse Condominiums, Tufts University Science and Technology Center, and Outside the Lines Studio, sound insulation improvements would be effective in reducing noise from the Proposed Action. Sound insulation improvements would be provided for 36 units in the Pearl Street Apartments, 27 units in the Powderhouse Condominiums, three laboratories and three classrooms on 1st floor and five labs on 2nd floor of the Tufts University Science and Technology Center, and the main classroom of the Outside the Lines Artist Studio. These improvements would be effective in improving the OILR and keeping future noise levels below 45 Ldn and 65 Lmax at the Pearl Street Apartments and below 65 Lmax at the Tufts University Science and Technology Center and Outside the Lines Studio.

Sound insulation improvements to the Pearl Street Apartments would include replacing or retrofitting the existing windows and adding a removable panel for the in-wall air conditioners that can be mounted over the units when they are not in use. These panels would increase the noise reduction of the building when the air conditioning is not in use and also provide greater thermal insulation. Sound insulation improvements to the Powderhouse Condominiums would include replacing or retrofitting existing windows and doors. These units have central HVAC, so no modifications to the system are required. Since the Tufts Science and Technology building already has central HVAC, no modifications to the system are required. Sound insulation improvements to the Outside the Lines Studio would include retrofitting or replacing six small windows in the main classroom. Since this building also already has central HVAC, no modifications to the system are required. Further detail on sound insulation for these properties is included in Appendix F, *Noise and Vibration Technical Report*.

In total, noise mitigation by means of 17 noise barriers totaling approximately 12,700 feet in length and sound insulation improvements to the Pearl Street Apartment building, Powderhouse Condominiums, Outside the Lines Studio building, and the Tufts University Science and Technology Center would be feasible, reasonable, and effective in mitigating all potential noise impact due to the Proposed Action. The noise barriers would be effective in reducing noise levels from transit sources typically 7 to 11 decibels and would result in substantial reduction in future noise levels in comparison to existing noise levels at many locations. Along the existing MBTA Fitchburg Line and MBTA Lowell Line, noise barriers would reduce future noise levels six to seven dBA below existing levels on average.

The total estimated cost for noise mitigation would be $6.6 million including $4.2 million for noise barriers based on $30 per square foot (not including design or inspection costs) and $2.4 million for sound insulation improvements based on $25,000 per residential unit in multi-family buildings (36 units in Pearl Street Apartments and 27 units in Powderhouse Condominiums), $750,000 for the Tufts University Science and Technology Center building, and $50,000 for the Outside the Lines Studio.

Table 7.3-8 presents a summary of noise sensitive receptors that would be exposed to moderate and severe airborne noise impact and ground-borne noise impact with and without noise mitigation. Without mitigation, 152 noise-sensitive receptors would be exposed to impact due to the relocation of the existing commuter lines and the introduction of the Green Line trains. These include 108 moderate impacts and 40 severe impacts at single-family and multi-family residential buildings, moderate impact at Tufts University Science and Technology Center and Outside the Line Artist’s Studio, moderate impact at Trum Playground, severe noise impact at the Walnut Street Center near Union Square and ground-borne noise impact at Tufts Bacon Hall and Tufts Curtis Hall. With mitigation, there would be no residual impacts due to the Proposed Action.

Table 7.3-8 Summary of Potential Airborne and Ground-Borne Noise Impact Without and With Mitigation

| Residential Buildings Impacted | | | | Institutional Buildings and Parks Impacted | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Without Mitigation | | With Mitigation | | Without Mitigation | | | With Mitigation | | |
| Moderate | Severe | Moderate | Severe | Moderate | Severe | Ground-Borne Noise | Moderate | Severe | Ground-Borne Noise |
| 108 | 40 | 0 | 0 | 3[1] | 1 | 2[2] | 0 | 0 | 0 |

Source: Harris Miller Miller and Hanson, Inc., *Green Line Extension Noise and Vibration Technical Report*, August 2011.
1 Institutional airborne noise impacts include the Tufts University Science and Technology Center, Outside the Lines Studio and Trum Playground.
2 Ground-borne noise impact includes Tufts Bacon Hall (no windows facing tracks) and Tufts Curtis Hall (WMFO radio station).

### Summary

Noise mitigation by means of 17 noise barriers totaling approximately 12,700 feet in length and sound insulation improvements to the Pearl Street Apartment building, Powderhouse Condominiums, Outside the Lines Studio building, and the Tufts University Science and Technology Center would be feasible, reasonable, and effective in mitigating all potential noise impact due to the Proposed Action. The noise barriers would be effective in reducing noise levels from transit sources typically 7 to 11 dBA and would result in substantial reduction in future noise levels in comparison to existing noise levels at many locations.

## 7.3.5 Vibration

The purpose of vibration mitigation is to minimize adverse effects from a project at sensitive locations. While the consideration of noise mitigation is well-defined, there is more variability in the approach to vibration mitigation and the specific measures that may be considered. The goal for mitigating potential vibration impact from the Green Line Extension project is to reduce future vibration below the impact criteria, which is 72 VdB for Green Line trains and 75 VdB for commuter rail trains. At some locations, mitigation measures that would reduce vibration levels five decibels or more would be considered reasonable and effective with the intention of keeping future vibration levels at or below existing vibration levels. For buildings with the potential for structural damage from train operations or construction, mitigation measures must be implemented to reduce levels below the criterion for potential damage. Proposed vibration mitigation locations are shown in Figures 6.8-1 through 6.8-5.

The effectiveness of specific vibration mitigation measures is dependent on several factors such as the component design, installation techniques, axle loads of the trains, and frequencies of concern. Common vibration mitigation options are:

- Resilient rail fasteners are specially designed fasteners that reduce vibration between the rails and the ties. Resilient rail fasteners typically reduce vibration by 5 to 10 VdB.

- Ballast mats are rubber or other elastomer pads placed in the trackform between the ballast and the sub-grade. Ballast mats typically reduce vibration levels 10 to 15 VdB.
- Resiliently supported ties have a rubber or other resilient material placed between the ties and the ballast. These ties are typically effective in reducing vibration 10 VdB.
- Similar to noise, special trackwork such as turnouts and crossovers increase vibration levels of the trains. Mitigation includes using special hardware or relocating special trackwork away from sensitive areas.
- Maintenance programs can also be essential for controlling vibration. Maintaining a proper wheel/rail profile, minimizing the number and extent of wheel flats and minimizing potential rail corrugation are important factors. Rail grinding, truing wheels, and monitoring wheel/rail profiles can be effective means of reducing potential vibration impact.

Vibration mitigation measures generally perform better for light rail vehicles because they do not weigh as much as commuter trains. Generally, well-designed and properly installed ballast mats or resilient rail fasteners would be effective in reducing vibration levels up to 15 VdB for the Green Line trains and up to 10 VdB for commuter trains, keeping future vibration levels generated from commuter trains at or below existing levels and reducing vibration levels generated from Green Line trains below the impact criterion. Although these mitigation measures would provide a substantial reduction in vibration levels and future levels would be less than existing levels, future vibration levels are still projected to be above the impact criteria at some locations. These locations are considered to be residual vibration impacts from the Proposed Action.

A vibration reduction goal for mitigation measures, such as ballast mats, resilient fasteners, or resiliently supported ties, would be specified in the bid documents. Suitable mitigation measures would be introduced into the Proposed Action to achieve the mitigation goal.

Table 7.3-9 summarizes the locations, length, and rail line of proposed vibration mitigation for the Proposed Action (tracks). A total of 21,500 track-feet of track vibration isolation is proposed to mitigate potential impacts. Track vibration isolation would be ballast mats, resiliently supported ties or resilient fasteners. An estimated cost for installed ballast mats or resiliently supported ties is $3.9 million based on a cost of $180 per track-foot and an estimated cost for resilient fasteners is $6.5 million based on a cost of $300 per track-foot. Figures 6.8-1 through 6.8-5 show the vibration track isolation locations.

## Table 7.3-9 Summary of Proposed Vibration Mitigation Measures for Tracks

| Mitigation Location | Location | Track Isolation Length (ft) | Rail Line |
|---|---|---|---|
| V-1 | Glass Factory Condominiums and Hampton Inn [1] | 450 | Green Line |
| V-2 | Brickbottom Artists Building (northeast façade) [1] | 650 | Green Line |
| V-3 | Brickbottom Artists Building (south façade) [2] | 600 | Green Line |
| V-4 | Alston Street (south of Cross Street) | 300 | Green Line |
| V-5 | Tufts Street/Avon Place/Auburn Avenue (south of Cross Street to McGrath Highway) | 950 | Commuter |
| V-6 | Gilman Street (McGrath Highway to Walnut Street) | 800 | Commuter |
| V-7 | Medford Street (under Walnut Street) | 400 | Green Line |
| V-8 | Pearl Street Apartments | 200 | Commuter |
| V-9 | Richdale Avenue (School Street to Sycamore Street) | 900 | Commuter |
| V-10 | Lowell Street/Nashua Street/Hinckley Street/Berwick Street (Lowell Street to Charles E Ryan Road) | 1,200 | Commuter |
| V-11 | Murdock Street (south of Cedar Street) | 400 | Green Line |
| V-12 | Cedar Street (north of Cedar Street) | 150 | Commuter |
| V-13 | Newbern Avenue/Morton Avenue/Granville Avenue/Winchester Place/Wareham Street (Broadway to Warren Street) | 1,250 | Commuter |
| V-14 | Tufts University Science and Technology Center | 700 | Commuter |
| V-15 | Tufts Bacon Hall [3] | 200 | Green Line |
| V-16 | Outside the Lines Artist Studio | 250 | Commuter |
| V-17 | Tufts Bray Laboratory | 350 | Green Line |
| V-18 | Tufts Curtis Hall [3] | 250<br>250 | Green Line<br>Commuter |
| V-19 | Horace Street | 250<br>250 | Green Line<br>Commuter |
| Total Length of Track Vibration Isolation (feet) | | 10,750 (21,500 track-feet) | |
| Total Cost of Mitigation (if Ballast Mats or Resiliently Supported Ties) | | $3.9 million | |
| Total Cost of Mitigation (if Resilient Fasteners) | | $6.5 million | |

Source: Harris Miller Miller and Hanson, Inc., *Green Line Extension Noise and Vibration Technical Report*, August 2011. Figures 6.8-1 through 6.8-5 show the vibration mitigation locations.
1 Mitigation included to reduce airborne noise.
2 Mitigation on Union Square Inbound track is to reduce airborne noise and mitigation on Union Square Outbound track is for ground-borne vibration.
3 Mitigation is required for ground-borne noise.

Special trackwork (turnouts and crossovers) cause local increase in vibration levels of up to 10 VdB. In addition to the locations of proposed vibration mitigation shown above, relocating special trackwork (turnouts and crossovers) away from sensitive receptors or using specially engineered trackwork (flange-bearing, spring-rail or moveable-point frogs) would minimize potential vibration impact at some locations.

Table 7.3-10 provides a summary of crossovers and turnout locations that are recommended for specially engineered trackwork or relocation. These trackwork mitigation locations are shown on Figures 6.8-1 through 6.8-5.

### Table 7.3-10 Summary of Proposed Vibration Trackwork Mitigation Measures for Crossovers and Turnouts

| Special Trackwork Location (Civil Station No.) | Location | Type of Special Trackwork | Rail Line |
|---|---|---|---|
| A (Union Square Mainline Outbound 12+00) | Brickbottom Artists Building (South Façade) | Turnout (Union Square Outbound Mainline to Union Square Outbound Yard Lead) | Green Line |
| B (Union Square Mainline Inbound 106+50) | Brickbottom Artists Building (South Façade) | Turnout (Union Square Inbound Mainline to Union Square Inbound Yard Lead) | Green Line |
| C (Fitchburg Outbound 3509+00 and 3512+00) | Brickbottom Artists Building (South Façade) | Two Turnouts (Fitchburg Outbound Mainline to BET Drill Track and to Spur Line) | Commuter |
| D (NH Mainline Outbound 192+00 and 196+00) | Granville Ave/Winchester Place | Interlocking (two double crossovers) | Commuter |
| E (Medford Mainline Outbound 362+00) | College Avenue | Number 8 Double Diamond Crossover | Green Line |

Source: Harris Miller Miller and Hanson, Inc., *Green Line Extension Noise and Vibration Technical Report*, August 2011.

Mitigation for the five properties (85 Morton Avenue, 86 Morton Avenue [commercial property], 53 Granville Avenue, 6 Winchester Place [rear building], and 15 Winchester Street) where vibration levels are projected to exceed criterion for potential structural damage includes track vibration isolation (V-13) and the relocation or use of trackwork mitigation (flange-bearing, spring-rail or moveable-point frogs) for the commuter track interlocking special trackwork (Location D). These two mitigation measures would be expected to decrease vibration levels by at least 15 VdB which would reduce levels below the criterion for potential structural damage.

Table 7.3-11 presents a summary of vibration-sensitive receptors that would be exposed to impact with and without vibration mitigation. Without mitigation, vibration impact is projected at 83 single-family and multi-family residential buildings and at five institutional buildings (Tufts University Science and Technology Center, Tufts Bacon Hall, Tufts Bray Laboratory, Tufts Curtis Hall and Outside the Line Artist’s Studio). With mitigation, there would be 37 residual impacts to residential properties and one residual impact to the Tufts University Science and Technology Center for the potential impact to vibration-sensitive equipment. Although future vibration levels are expected to be at or below existing levels at these locations with mitigation, they are considered residual impacts since future levels would still be above the vibration criteria with mitigation.

### Table 7.3-11 Summary of Potential Vibration Impact Without and With Mitigation

| Residential Buildings Impacted | | Institutional Buildings Impacted[1] | |
|---|---|---|---|
| Without Mitigation | With Mitigation | Without Mitigation | With Mitigation |
| 83 | 37 | 5[1] | 1 [2] |

Source: Harris Miller Miller and Hanson, Inc., *Green Line Extension Noise and Vibration Technical Report*, August 2011.

1 Institutional buildings include the Tufts University Science and Technology Center, Tufts Bacon Hall, Tufts Bray Laboratory, Tufts Curtis Hall and Outside the Lines Studio.

2 Residual impact would occur at Tufts University Science and Technology Center for potential vibration impact to vibration-sensitive equipment.

Vibration mitigation, including 21,500 track-feet of vibration mitigation such as ballast mats, resilient fasteners, or resiliently supported ties on the proposed Green Line tracks and the relocated commuter rail tracks, and the relocation or use of specially engineered trackwork (flange-bearing, spring-rail or moveable-point frogs) for crossovers and turnouts at five locations, would be effective in keeping future vibration levels at or below existing levels for commuter trains and reducing future vibration from Green Line trains below the impact criterion.

### 7.3.6 Water Quality/Stormwater

Impervious surface by 1.2 acres for the overall project have been reduced as a direct result of the use of the Option L site for the maintenance and storage facility location. Because part of the Option L site is currently covered by buildings and pavement but would be replaced with substantial areas of trackwork with pervious stone ballasted surface areas use of this site for the maintenance and storage facility would decrease impervious area by approximately 3.2 acres. Taking into consideration the increase in impervious surfaces at the station areas and the reduction in impervious surfaces at the maintenance and storage facility, there would be no net increase in impervious surfaces as a result of the overall Proposed Action.

New and expanded stormwater management systems would be required to collect the runoff from these areas. These systems would discharge into the existing municipal stormwater drainage systems. Proposed stormwater management devices include:

- Deep sump catch basins to collect runoff from paved areas;
- Underdrains beneath the rail ballast to collect runoff within the rail corridor;
- Hydrodynamic particle separators to treat pavement runoff;
- Low Impact Development practices, where feasible, to maintain natural hydrology (*e.g.*, raingardens to treat disconnected roof drainage and/or parking runoff);
- Underground infiltration/detention chambers to store and infiltrate runoff; and
- Overflow from the underground chambers to municipal storm drainage systems.

The proposed stormwater management system would include detention/infiltration systems as needed to maintain existing flow rates at existing outfalls. The extent of infiltration for each system would be determined during a later phase of the design based on the analysis of soil and groundwater conditions at the proposed system location. The infiltration systems would be sized taking into consideration soil conditions, and the remaining volume of runoff would be stored and released through a controlled outlet to match the existing rate of flow. Where infiltration is not possible due to poorly draining soils or high groundwater, subsurface detention systems would be sized to maintain predevelopment flow rates at each design point.

Maintaining existing flow rates would avoid exacerbating the existing effects of CSOs on the receiving waters.

Where possible, the detention/infiltration systems would utilize Low Impact Development concepts such as green roofs and rain gardens and treat the water quality of the stormwater. These systems work to hold stormwater in natural systems such as soil and vegetation. Treatment of stormwater would be incorporated, where possible, through bioretention basins or proprietary water quality devices, especially where stormwater would discharge directly into the Charles River.

Suspended solids removal would not be necessary for most of the project area because the railroad right-of-way would generate negligible suspended solids as it is not salted or sanded as roads and parking lots are. Because of space constraints at the station sites, suspended solids removal would be accomplished with proprietary water quality devices such as hydrodynamic separators like the Vortechs or Stormceptor. These units use whirlpool-like chambers in a compact footprint to remove floating debris and suspended solids. These units would treat stormwater flows prior to their discharge to proposed detention systems or to the existing drainage system. Each device would be sized to treat the 10-year flow rate at the proposed outfall and to maintain the predevelopment rate of flow in the existing drainage system.

MassDOT would prepare a detailed long-term operations and maintenance plan for the Proposed Action's stormwater management system. A drainage system would meet MassDEP Stormwater Standards to the extent feasible, including meeting any applicable TMDL requirements. The Proposed Action would be required to meet requisite NPDES permit obligations, including the MS4 requirements to implements construction site runoff controls, post-construction runoff controls, and pollution prevention/good housekeeping measures.

### 7.3.7 Cultural Resources

Project activities would result in an adverse effect on seven historic resources listed or eligible for listing on the National Register. Mitigation would be provided for these resources that would be adversely affected by permanent aspects of the project.

The Cambridge elevated steel portion of the Lechmere Viaduct, considered by the MHC a contributing structure to the National Register-listed Charles River Basin Historic District, is individually eligible for listing in the National Register and would be impacted by the Proposed Action. A new connection would be constructed between the existing concrete portion of viaduct and new track. The existing National Register-eligible MBTA Lechmere Station in Somerville would also be directly impacted. It would be abandoned and demolished and a new station would be constructed on the east side of Monsignor O'Brien Highway/Route 28. The proposed Ball Square Station would have a direct effect on the National Register-eligible Somerville Automobile Company building in Somerville due to its demolition to accommodate the new station. At the National Register-listed Susan Russell House in Somerville, a 7-foot tall noise barrier on the top of the embankment along the right-of-way would be necessary to effectively mitigate potential noise impact at this location.

This work would require mitigation as stipulated in the MOA (Appendix G, *Memorandum of Agreement*). Mitigation at these individual properties would consist of archival documentation prior to any demolition or construction activities associated with the project. The FTA and the MBTA will consult with the MHC and the Somerville Historic Preservation Commission during design and construction to incorporate measures to minimize the effects of these stations on the historic districts, as stipulated in the MOA. Historic interpretive signage may also be included at the site of the proposed relocated Lechmere Station as well as the proposed Ball Square Station. The noise barrier behind the Susan Russell House will be designed in consultation with the Commissions to consist of materials and color compatible with the historic character of the property to minimize any adverse effect.

The proposed Lowell Street Station would have a potential visual effect on the National Register-eligible Powder House/Winter Hill District in Somerville. The proposed Gilman Square Station would have a potential visual effect on the National Register-eligible Gilman Square Historic District in Somerville. Consultation with the MHC and the Somerville Historic Preservation Commission will ensure the design of these stations is context-sensitive to the nature of the National Register-eligible Historic Districts.

The proposed Gilman Square Station would have no adverse effect on the individually National Register-eligible Reid and Murdock Company Warehouse, although partial land acquisition is required to accommodate the station. Land currently used as a parking lot for the vacant warehouse building and a non-contributing loading bay in the rear of the property, would be required for the construction of the station. The construction of a driveway at the Gilman Square Station would block access to the Reid and Murdock Company Warehouse three-bay loading dock at this property; however, this change would not alter its potential use as an industrial facility and impact would be low. No mitigation is required.

With the exception of these areas, work within the existing railroad right-of-way is not likely to directly affect significant historic resources, as no significant resources are found inside the railroad right-of-way. A number of historic architectural resources immediately abut the right-of-way and would be indirectly affected by noise and vibration.

Noise mitigation for the Susan Russell House would include noise barriers. Potential ground-borne noise impact would be mitigated at the WMFO radio station at the National Register-eligible Tufts University Curtis Hall in Medford. Vibration track isolation would effectively mitigate this potential noise impact on the radio station.

Track vibration isolation would effectively mitigate potential interference impacts of modern vibration-sensitive equipment located in the National Register-eligible Tufts University Bray Laboratory in Medford.

Two areas of archeological sensitivity were previously identified within the project APE. The project construction would not affect one area, and subsequent investigations found that there is extensive fill and/or previously disturbed belowground soil contexts at the second location. Therefore, it is unlikely that intact archeological resources would be discovered during construction. However, should any unidentified archeological resources be discovered during construction, MassDOT would ensure that appropriate notification and preservation procedures are followed, as stipulated in the MOA (Appendix G, *Memorandum of Agreement*).

### 7.3.8 Visual Environment

The MBTA would provide vegetation on and/or above retaining walls to minimize visual changes. MassDOT and the MBTA would work with affected communities on design of proposed noise barriers and vegetated walls.

### 7.3.9 Section 4(f) Resources

Noise barrier mitigation at Trum Playground and near the Park at Somerville Junction and the Hoyt-Sullivan Playground would effectively eliminate any indirect noise impacts to these resources to a condition equivalent to, or better than, that which would occur if the project were not built.

A MOA (Appendix G, *Memorandum of Agreement*) will be executed that will present the agreed-upon measures to mitigate adverse effects to three historic resources identified as constructive uses under Section 4(f) of the U.S. DOT Act of 1966[2] through permanent acquisition of land for transportation purposes. Archival photographic documentation of the Lechmere Viaduct, Lechmere Station, and the Somerville Automobile Company will be prepared in consultation with the MHC and the relevant local historic commission(s) and in accordance with the documentation methodology described in the MOA.

The MBTA will ensure that the design plans and construction specifications for any elements of the project that affect above-ground historic properties are context-sensitive and are submitted to the MHC and the local historic commissions prior to construction for review and comment.

2 *Section 4(f) of the United States Department of Transportation Act of 1966* (Amended March 12, 2008 in 73 FR 13395; implemented at 23 U.S.C. 138 and recodified at 49 United States Code, Subtitle I, Section 303(c)).

The MBTA Design Department, following MBTA design protocol review, will develop interpretive displays to be located at the site of the relocated Lechmere Station and the proposed Ball Square Station.

### 7.3.10 Public Involvement

As a project commitment, MassDOT and the MBTA would continue civic engagement opportunities during the design process. MassDOT and the MBTA would provide transparent public information and outreach process through construction, as further described in the PIP.

As a project commitment, MassDOT has engaged interested parties through the Design Working Group. Through independent Design Working Group meetings and station workshops MassDOT would continue to solicit input and recommendations from interested stakeholders.

### 7.3.11 Design

Mitigation for land use impacts include refining project designs to further minimize temporary and permanent impacts on local neighborhoods and property owners.

As the design advances, MassDOT and the MBTA project commitments include:

- Facilitating future transit and transportation projects such as light rail expansion or connections to existing infrastructure to the extent possible.
- Implementing "green" design elements (recycled or recyclable materials or incorporate vegetation) in design of proposed retaining walls, stations, and the maintenance and storage facility.
- Designing all stations in compliance with ADA standards, Massachusetts AAB standards; MBTA's settlement agreement with the BCIL; and applicable National Fire Protection Association standards.

## 7.4 Summary of Project and Mitigation Commitments

Potential permanent impacts resulting from constructing the Proposed Action would be mitigated to the extent feasible, as summarized in Table 7.4-1. Anticipated, known costs related to each mitigation commitment are also provided.

Table 7.4-1 Project and Mitigation Commitments

| Human and Environmental Resources | Mitigation | Implementation Schedule | Cost Estimate | Implementation Responsibility |
|---|---|---|---|---|
| Traffic and Transportation Systems | Provide roadway and signal modifications at 12 specific intersections in order to prevent adverse traffic impacts from the project (See Section 7.3.3 and Figure 5.6-1):<br>• Boston Avenue at Winthrop Street<br>• Boston Avenue at College Avenue<br>• Washington Street at McGrath Highway<br>• Prospect Street at Somerville Avenue<br>• Washington Street at Somerville Avenue/Webster Street<br>• Washington Street at Tufts Street<br>• Medford Street at Pearl Street<br>• Broadway at Boston Avenue/Rogers Avenue<br>• Monsignor O'Brien Highway/Route 28 at Third Street<br>• Monsignor O'Brien Highway/Route 28 at Water Street<br>• Monsignor O'Brien Highway/Route 28 at North First Street/East Street/Cambridge Street<br>• Cambridge Street at First Street | Within 12 months after revenue service | $13 M | MBTA D/B Contractor[1] |
| | Provide pedestrian improvements at 29 specific locations to improve pedestrian flow and safety (See Section 7.3.3, Table 7.3-1 and Figure 5.6-1):<br>• Boston Avenue at North Street<br>• Boston Avenue at Winthrop Street<br>• Boston Avenue between Winthrop Street and College Avenue (mid-block)<br>• Boston Avenue at Harvard Street<br>• Powder House Rotary<br>• Boston Avenue at Broadway<br>• College Avenue between Boston Street and Frederick Avenue (mid-block)<br>• College Avenue at George Street<br>• Main Street at George Street<br>• Main Street at Harvard Street<br>• Medford Street at Broadway<br>• Main Street at Mystic Valley Parkway Ramps<br>• Main Street at Mystic Avenue<br>• Medford Street at Lowell Street<br>• Medford Street at Central Street<br>• Medford Street at School Street<br>• Medford Street at Pearl Street<br>• Medford Street at Walnut Street<br>• Medford Street at Highland Avenue<br>• Highland Avenue at Lowell Street<br>• Highland Avenue at Central Street<br>• Washington Street at McGrath Highway<br>• Washington Street at Tufts Street | Within 12 months before revenue service | $1 M | MBTA D/B Contractor[1] |

## Table 7.4-1 Project and Mitigation Commitments (continued)

| Human and Environmental Resources | Mitigation | Implementation Schedule | Cost Estimate | Implementation Responsibility |
|---|---|---|---|---|
| Traffic and Transportation Systems (continued) | • Washington Street at Inner Belt Road<br>• Medford Street at Somerville Avenue /McGrath Highway<br>• Washington Street at Somerville Avenue/Prospect Street<br>• Washington Street at Somerville Avenue/Webster Street<br>• Washington Street at Kirkland Street<br>• Prospect Street at Webster Street | | | |
| | Optimize traffic signal timing and phasing to maximize the efficiency of signalized intersections in the Proposed Action. | Within 12 months before revenue service | N/A | MBTA D/B Contractor[1] |
| | Work with cities to develop station-area parking enforcement plans. | Within 12 months before revenue service | N/A | MBTA |
| | Work with the MBTA to evaluate opportunities to improve connections between the new stations and existing bus connections. | During design and construction | N/A | MBTA D/B Contractor[1] |
| | Work with cities and applicable emergency personnel during design of intersection mitigation measures, including the development of construction management and detour plans. | During design and construction | N/A | MBTA PM/CM Team[2] |
| Noise | Mitigate noise impacts by providing noise barriers or sound insulation. Provide mitigation for moderate noise impact where existing day-night sound levels (Ldn) are above 65 dBA. Provide mitigation for impacts with no significant outdoor land use if interior noise levels are above 45 dBA from project sources or single-event maximum noise levels (Lmax) are above 65 dBA. Provide 17 noise barriers totaling approximately 12,700 feet in length at the following locations (See Section 7.3.4, Tables 7.3-6 and 7.3-7, and Figures 6.7-1 through 6.7-6.):<br>• N1 - Glass Factory Condominiums and Hampton Inn Hotel<br>• N2 - Brickbottom (Northeast Façade)<br>• N3 - Brickbottom (South Façade)<br>• N4 - Alston Street<br>• N5 - Between Cross Street and McGrath Highway (Avon Place)<br>• N6 - Between McGrath Highway and Walnut Street (Gilman Street)<br>• N7 - Between School Street and Sycamore Street (Richdale Avenue)<br>• N8 - Sycamore Street near Richdale Avenue<br>• N9 - Vernon Street<br>• N10 - Nashua Street/Henderson Street/Hinckley Street<br>• N11 - Trum Playground<br>• N12 - Cedar Street and Wilson Avenue | Early phases of construction, where appropriate | $4.2 M noise barriers | MBTA D/B Contractor[1] |

## Table 7.4-1 Project and Mitigation Commitments (continued)

| Human and Environmental Resources | Mitigation | Implementation Schedule | Cost Estimate | Implementation Responsibility |
|---|---|---|---|---|
| Noise (continued) | • N13 - Between Cedar Street and Broadway (Boston Avenue)<br>• N14- Newbern Ave/Morton Ave/Granville Ave<br>• N15 - Burget Avenue<br>• N16 - Horace Street<br>• N17 - Walnut Street Center | | | |
| Vibration | Provide sound insulation improvements at the following locations (See Section 7.3.4 and Figures 6.7-1 through 6.7-6):<br>• Pearl Street Apartment building<br>• Powderhouse Condominiums<br>• Outside the Lines Studio building<br>• Tufts University Science and Technology Center | Early phases of construction, where appropriate | $2.4 M sound insulation | MBTA D/B Contractor[1] |
| | • V10 - Lowell Street/Nashua Street/Hinckley Street/Berwick Street (Lowell Street to Charles E Ryan Road)<br>• V11 - Murdock Street (south of Cedar Street)<br>• V12 - Cedar Street (north of Cedar Street)<br>• V13 - Newbern Avenue/Morton Avenue/Granville Avenue/Winchester Place/Wareham Street (Broadway to Warren Street)<br>• V14 - Tufts University Science and Technology Center<br>• V15 - Tufts Bacon Hall<br>• V16 - Outside the Lines Artist Studio<br>• V17 - Tufts Bray Laboratory<br>• V18 - Tufts Curtis Hall<br>• V19 - Horace Street | Within 12 months before revenue service | $3.9 M if ballast mats or resiliently supported ties<br>$6.5 M if resilient fasteners | MBTA D/B Contractor[1] |
| | Relocate specially engineered trackwork to further minimize or mitigate potential vibration impacts at the following crossover and turnout locations (See Section 7.3.5, Table 7.3-10 and Figures 6.7-1 and 6.8-1 through 6.8-5.):<br>• A – Brickbottom Artists Building South Façade Green Line Turnout (Union Square Outbound Mainline to Union Square Outbound Yard Lead)<br>• B - Brickbottom Artists Building South Façade Green Line Turnout (Union Square Inbound Mainline to Union Square Inbound Yard Lead)<br>• C - Brickbottom Artists Building South Façade Two Commuter Turnouts (Fitchburg Mainline to BET Drill Track and to Spur Line)<br>• D – Granville Avenue / Winchester Place Commuter Interlocking (two double crossovers)<br>• E – College Avenue Green Line Number 8 Double Diamond Crossover | PE Design Phase | N/A | MBTA PM/CM Team[2] |

Table 7.4-1 Project and Mitigation Commitments (continued)

| Human and Environmental Resources | Mitigation | Implementation Schedule | Cost Estimate | Implementation Responsibility |
|---|---|---|---|---|
| Hazardous Materials | Consult with MassDEP during design and construction to ensure planning and implementation of demolition and management of contaminated soils is consistent with applicable MassDEP regulations and recommendations. | During design and construction | N/A | MBTA Environmental Team[3] |
| Socioeconomics | In accordance with Uniform Act procedures, work with property owners to provide fair market value of acquisition and job relocations. | Prior to beginning of construction | N/A | MBTA Real Estate Team[4] |
| Land Use | Work with the community in the area of the future Mystic Valley/Route 16 to consider land use and station design elements. | Prior to beginning of construction | N/A | MassDOT/MAPC |
| | Complete the final design for the proposed Somerville Community Path between Lowell Street and the Inner Belt area. Work with City of Somerville to identify opportunities for state and Federal funding for construction of Community Path. | Within 12 months before revenue service | $2 M | MBTA PM/CM Team[2] |
| Water Quality/ Stormwater | Update the Operation and Maintenance plan in the SWPPP to include a detailed outline of inspection and cleaning schedules for stormwater management practices, including detention areas and deep sump catch basins. | Within 12 months before revenue service | N/A | MBTA D/B Contractor[1] |
| | Implement all aspects of the SWPPP including recommendations in annual updates based on new or improved procedures or changes to operations. | Within 12 months after revenue service | N/A | MBTA D/B Contractor[1] |
| Visual Environment | Provide vegetation on and/or above retaining walls to minimize visual changes. | During design and construction | TBD | MBTA D/B Contractor[1] |
| | Work with affected communities on design of noise barriers and vegetated walls. | PE Design Phase | N/A | MBTA PM/CM Team[2] |
| Cultural Resources and Section 4(f) Resources | Perform archival photographic and written documentation of historic structures to be removed or altered (Lechmere Station/Lechmere Viaduct, Somerville Automobile Company Building) | Prior to beginning of construction | $45,000 | MBTA PM/CM Team[2] |
| | Following MBTA design protocol review, develop interpretative displays of Lechmere Station/Lechmere Viaduct and the Somerville Automobile Company Building, in consultation with the FTA, the MHC and relevant historical commissions. | Prior to beginning of construction | N/A | MBTA PM/CM Team[2] |
| | Submit design plans and construction specifications for project elements that affect above-ground historic properties for review by MHC, local historical commissions, and the Design Working Group. | Prior to beginning of construction | N/A | MBTA PM/CM Team[2] |
| | Construct noise barrier adjacent to historic Susan Russell House with context-sensitive materials and colors. | During design and construction | N/A | MBTA D/B Contractor[1] |

Table 7.4-1 Project and Mitigation Commitments (continued)

| Human and Environmental Resources | Mitigation | Implementation Schedule | Cost Estimate | Implementation Responsibility |
|---|---|---|---|---|
| Public Involvement | Continue civic engagement opportunities during the design process. Provide transparent public information and outreach process through construction. | Duration of project | N/A | MassDOT/MBTA |
| | Engage interested parties through the Design Working Group. | Duration of project | N/A | MassDOT/MBTA |
| | Conduct land use workshops with affected communities to further identify community needs and issues near the proposed station areas. | Completed in May/June 2010 | N/A | MassDOT |
| Design | As design advances, facilitate future transit/transportation projects such as light rail expansion or connections to existing infrastructure to the extent possible. | Prior to beginning of construction | N/A | MBTA D/B Contractor[1] |
| | Implement “green” design elements (recycled or recyclable materials or incorporate vegetation) in design of proposed retaining walls, stations and maintenance and storage facility. | During design and construction | N/A | MBTA D/B Contractor[1] |
| | During design, refine project designs to further minimize temporary and permanent impacts on local neighborhoods and property owners. | Prior to beginning of construction | N/A | MBTA D/B Contractor[1] |
| | Design all stations in compliance with ADA standards, Massachusetts AAB standards; MBTA’s settlement agreement with the Boston Center for Independent Living (BCIL) and applicable National Fire Protection Association standards. | Prior to beginning of construction | N/A | MBTA D/B Contractor[1] |

1 MBTA D/B Contractor = Contractor selected and coordinated by the MBTA to handle Design and Build phase of the project
2 MBTA PM/CM Team = Team selected by the MBTA to handle Program Management, Contract Management and oversight of Preliminary Engineering.
3 MBTA Environmental Team = MBTA Environmental Department Staff
4 MBTA Real Estate Team = MBTA Real Estate Department Staff and asset manager Transit Realty Associates (TRA)
TBD = To be determined during final design
N/A = Cost not applicable for this item

## 7.5 Construction Period Mitigation

This section summarizes the mitigation measures proposed during the project construction period to prevent or reduce environmental impacts of the Proposed Action. Table 7.5-1 provides a summary of the project and mitigation commitments for the construction period.

### 7.5.1 General

Temporary, short-term impacts from construction activities would be mitigated to the extent feasible. Specific construction mitigation measures would be incorporated into the contract documents and specifications governing the activities of contractors and subcontractors constructing elements of the project. Prior to construction, MassDOT would prepare a detailed plan to address various construction period impacts through coordination with cities and appropriate emergency personnel.

This plan would seek to avoid, minimize and mitigate potential impacts to the following environmental resources:

- Vehicular traffic
- Pedestrian and bicycle traffic
- On-street parking
- Public access
- Emergency access to local businesses and residences
- Dust
- Noise
- Odor
- Rodents
- Construction-related nuisance conditions

### 7.5.2 Traffic and Transportation Systems

Bridge construction would be staged to ensure that adjacent bridges are not closed simultaneously. During construction, temporary detours would be established to minimize traffic disruptions. MassDOT will work with cities and applicable emergency personnel to ensure that appropriate safety measures are incorporated throughout the design and construction.

## 7.5.3 Air Quality

In an effort to reduce GHG emissions from temporary construction activities, the MBTA would contractually require the construction contractors to adhere to all applicable regulations regarding control of construction vehicles emissions. This would include, but not be limited to, maintenance of all motor vehicles, machinery, and equipment associated with construction activities and proper fitting of equipment with mufflers or other regulatory-required emissions control devices. As required by MassDEP regulations in 310 CMR 7.11, excessive idling of construction equipment would be prohibited.

Construction specifications would require that all diesel construction equipment used on-site would be fitted with after-engine emission controls such as diesel oxidation catalysts (DOCs) or diesel particulate filters (DPFs). The MBTA would also contractually require the construction contractors to utilize ultra low sulfur diesel fuel for all off-road construction vehicles as an additional measure to reduce air emissions from construction activities. The MBTA would put idling restriction signs on the premises to remind drivers and construction personnel of the state's idling regulation.

The contractor would also be responsible for protective measures around the construction and demolition work to protect pedestrians and prevent dust and debris from leaving the site or entering the surrounding community. Dust generated from earthwork and other construction activities like stockpiled soils would be controlled by spraying with water to mitigate wind erosion on open soil areas. Other dust suppression methods would be implemented to minimize the off-site transport of dust. Pavement would be swept regularly during the construction period to minimize the potential for vehicular traffic to create airborne dust and particulate matter.

## 7.5.4 Noise

Construction noise mitigation includes the preparation of a Noise Control Plan in conjunction with the contractor's specific equipment, schedule and methods of construction, maximum noise limits for each piece of equipment, prohibition on certain types of equipment during the nighttime hours and engineering noise control measures. An Acoustical Engineer would prepare the Noise Control Plan. This plan would be consistent with that specified in the Central Artery/Tunnel project 721.560 Noise Specification. Key elements to the plan would include:

- Identifying specific sensitive sites where noise monitoring would occur;
- Background noise monitoring prior to and during construction;
- Construction equipment noise certification testing;

- Prohibiting impact pile-drivers during evening and nighttime hours (*i.e.*, 6:00 PM to 10:00 PM and 10:00 PM to 7:00 AM);
- Prohibiting vibratory sheet pile driving and all impact devices including hoe rams, jackhammers and pavement breakers during nighttime hours;
- Requiring ambient-adjusting or manually adjusted backup alarms set to 5 dBA over background levels;
- Limiting truck idling to five minutes;
- Requiring acoustic shields for jackhammers, chainsaws and pavement breakers;
- Methods for projecting construction noise levels;
- Detailed engineering noise control measures;
- Methods for responding to community complaints; and
- Reporting noise monitoring results, noise reduction measures used, and responses to the community.

Noise control measures would be used to reduce noise emissions and potential impact to sensitive receptors where feasible. Many types of construction equipment include diesel engines which can be the largest noise source. Reducing engine noise is often a key element to mitigating potential impact. Examples of such noise control measures include:

- Shields, shrouds or intake and exhaust mufflers;
- Noise deadening materials adhered to chutes or storage bins;
- Temporary noise barriers;
- Acoustic enclosures;
- Specialized back-up alarms;
- Limiting the size of generators and the duration of their use; and
- Truck routes that minimize exposure to sensitive receptors.

### Post-Construction Noise Monitoring

The MBTA would continue to monitor noise after revenue service starts (with the proposed mitigation in place) to evaluate whether the actual noise levels correspond with the modeled values. If noise levels are found to be higher than the projections, the MBTA would investigate the cause and take appropriate corrective action.

## 7.5.5 Vibration

Mitigation of potential construction vibration impact will include vibration limits in the construction specification that the contractor is not allowed to exceed. For construction activities in close proximity to buildings with the potential for structural damage, the contractor will be required to monitor vibration levels. If the vibration limits are exceeded, mitigation measures such as the following will be introduced:

- Coordinating construction schedules such as avoiding nighttime construction in residential neighborhoods.
- Using alternative construction methods to minimize the use of impact and vibratory equipment (*e.g.*, pile drivers, compactors routing trucks away from sensitive receptors and maintaining smooth roadway surfaces).

### Post-construction Vibration Monitoring

Similar to the noise mitigation, the MBTA would continue to monitor vibration after revenue service starts (with the proposed mitigation in place) to evaluate whether the actual vibration levels correspond with the modeled values. If vibration levels are found to be higher than the projections, the MBTA would investigate the cause and take appropriate corrective action.

## 7.5.6 Water Quality/Stormwater

During construction, the contractor would install detention and infiltration systems to infiltrate peak runoff and to prevent any increase in peak flows to municipal stormwater drainage systems and to remove total suspended solids (TSS) from stormwater runoff prior to discharge. In addition, hydrodynamic particle separators would be installed by the contractor to treat pavement runoff. The contractor will use Low Impact Development practices, where feasible, to maintain natural hydrology (*e.g.*, raingardens to treat disconnected roof drainage and/or parking runoff).

A range of stormwater BMPs would likely be implemented during construction to minimize impacts:

- Develop and implement a SWPPP in accordance with NPDES and MassDEP standards;
- Stabilize any highly erosive soils with erosion control blankets and other stabilization methods, as necessary;
- Reinforce slopes using a hydroseed mix, as appropriate;
- Use dewatering controls, if necessary;

- Install a gravel entrance to any construction site to prevent sediment from being tracked onto roadways and potentially discharged to surface waters;
- Maintain construction equipment to prevent oil and fuel leaks; and
- Install catch basin protection as needed.

### 7.5.7 Hazardous Materials and Solid Waste

The MBTA would consult with MassDEP during design and construction to ensure planning and implementation of demolition and management of contaminated soils is consistent with applicable MassDEP regulations and recommendations. All protocols to adequately characterize, stockpile and dispose of materials encountered during construction would be followed.

### 7.5.8 Public Outreach

Additional information regarding the public outreach during the construction period can be found in the PIP. Key elements of the construction outreach plan include:

- Establishing a project construction office;
- Establishing the position of Green Line Extension project Ombudsman who would field all construction-period comments and complaints, coordinate with the cities, and respond to public concerns;
- Establishing a Construction Working Group, to advise MassDOT and the MBTA;
- Establishing a project email address and 24-hour phone hotline for public concerns;
- Providing frequent website updates of construction activities at www.mass.gov/greenlineextension;
- Hosting neighborhood construction kick-off meetings;
- Producing quarterly construction updates; and
- Developing a business outreach plan to assist local businesses during construction.

MassDOT would work with contractors to establish construction protocols. On-site resident engineers and inspectors would monitor all construction activities to ensure that mitigation measures are properly implemented. This monitoring will include maintaining a “Tracking Sheet” that will be included with project status reports. The construction mitigation measures are summarized in Table 7.5-1.

## Table 7.5-1 Summary of Construction Mitigation Commitments

| Environmental Categories | Mitigation | Implementation Schedule | Implementation Responsibility |
|---|---|---|---|
| General | Prior to construction, prepare a detailed plan to address various construction period impacts to various environmental resources (vehicular traffic, pedestrian and bicycle, on-street parking, public access, emergency access to local businesses and residences, dust, noise, odor, rodents, construction-related nuisance conditions) through coordination with cities and appropriate emergency personnel. | Prior to construction | MBTA PM/CM Team[1] |
| Traffic and Transportation Systems | Establish temporary detours to minimize traffic disruptions due to construction. | During construction | MBTA D/B Contractor[2] |
| | Stage bridge construction to ensure that adjacent bridges are not closed simultaneously. | During construction | MBTA D/B Contractor[2] |
| | Work with cities and applicable emergency personnel to ensure that appropriate safety measures are incorporated throughout construction. | During construction | MassDOT |
| Air Quality | Apply water to dry soil to prevent dust production. Use water for compaction in the fill areas and as a dust retardant in both the soil cut areas and haul roads. | During construction | MBTA D/B Contractor[2] |
| | Follow existing MassDEP's Solid Waste and Air Quality Control regulations and MBTA retrofit procedures for construction equipment to reduce emissions. | During construction | MBTA D/B Contractor[2] |
| | Comply with MassDEP's idling regulations. Post idling restriction signage on project construction sites. | During construction | MBTA D/B Contractor[2] |
| Noise | Prepare a Noise Control Plan in conjunction with the contractor's specific equipment and methods of construction. | During construction | MBTA D/B Contractor[2] |
| | Use specially quieted equipment with enclosed engines and/or high-performance mufflers. | During construction | MBTA D/B Contractor[2] |
| | Perform construction equipment noise certification testing. | During construction | MBTA D/B Contractor[2] |
| | Avoid nighttime construction in residential neighborhoods. | During construction | MBTA D/B Contractor[2] |
| | Require ambient-adjusting or manually adjusted backup alarms set to 5 dBA over background levels. | During construction | MBTA D/B Contractor[2] |
| | Keep truck idling to a minimum. | During construction | MBTA D/B Contractor[2] |
| | Set acoustic shield requirement for jackhammers, chainsaws, and pavement breakers. | During construction | MBTA D/B Contractor[2] |
| | Develop methods for projecting construction noise levels. | During construction | MBTA D/B Contractor[2] |
| | Develop methods for responding to community complaints. | During construction | MBTA D/B Contractor[2] |

## Table 7.5-1 Summary of Construction Mitigation Commitments (continued)

| Environmental Categories | Mitigation | Implementation Schedule | Implementation Responsibility |
|---|---|---|---|
| Noise (continued) | Establish a protocol for reporting noise monitoring results, noise reduction measures used, and responses to the community. | During construction | MBTA D/B Contractor[2] |
| | Use shields, shrouds, or intake and exhaust mufflers to control construction noise level. | During construction | MBTA D/B Contractor[2] |
| | Apply noise deadening materials to chutes or storage bins. | During construction | MBTA D/B Contractor[2] |
| | Install temporary noise barriers. | During construction | MBTA D/B Contractor[2] |
| | Apply acoustic enclosures. | During construction | MBTA D/B Contractor[2] |
| | Implement specialized back-up alarms. | During construction | MBTA D/B Contractor[2] |
| | Limit the size of generators and the duration of their use. | During construction | MBTA D/B Contractor[2] |
| | Develop truck routes that minimize exposure to noise-sensitive sites. | During construction | MBTA D/B Contractor[2] |
| | Develop other detailed engineering noise control measures, as appropriate. | During construction | MBTA D/B Contractor[2] |
| | Route construction equipment and vehicles through areas that would cause the least disturbance to nearby receptors where possible. | During construction | MBTA D/B Contractor[2] |
| | Fit any air-powered equipment with pneumatic exhaust silencers. | Prior to construction | MBTA D/B Contractor[2] |
| | Locate stationary construction equipment as far as possible from noise-sensitive sites. | During construction | MBTA D/B Contractor[2] |
| | Construct noise barriers, such as temporary walls or piles of excavated material, between noisy activities and noise-sensitive receivers. | Prior to construction | MBTA D/B Contractor[2] |
| | Monitor noise after service starts (with the proposed mitigation in place) to evaluate whether the actual noise levels correspond with the modeled values and take appropriate corrective actions if the actual values are found to be higher than the projections. | Within 12 months after revenue service | MBTA PM/CM Team[1] |
| Vibration | Configure truck routes that minimize exposure to vibration sensitive receptors and maintain smooth roadway surfaces. | During construction | MBTA D/B Contractor[2] |
| | Avoid nighttime construction in residential neighborhoods. | During construction | MBTA D/B Contractor[2] |
| | Use alternative construction methods to minimize the use of impact and vibratory equipment (e.g., pile drivers and compactors). | During construction | MBTA D/B Contractor[2] |
| | Monitor vibration after service starts (with the proposed mitigation in place) to evaluate whether the actual vibration levels correspond with the modeled values and take appropriate corrective actions if the actual values are found to be higher than the projections. | Within 12 months after revenue service | MBTA PM/CM Team[1] |

## Table 7.5-1 Summary of Construction Mitigation Commitments (continued)

| Environmental Categories | Mitigation | Implementation Schedule | Implementation Responsibility |
|---|---|---|---|
| Water Quality/ Stormwater | Install detention and infiltration systems to infiltrate peak runoff and to prevent any increase in peak flows to municipal stormwater drainage systems and to remove TSS from stormwater runoff prior to discharge. | During construction | MBTA D/B Contractor[2] |
| | Install hydrodynamic particle separators to treat pavement runoff. | During construction | MBTA D/B Contractor[2] |
| | Use Low Impact Development practices, where feasible, to maintain natural hydrology (e.g., raingardens to treat disconnected roof drainage and/or parking runoff). | During construction | MBTA D/B Contractor[2] |
| | Develop and implement a SWPPP in accordance with NPDES and MassDEP standards. | Prior to construction | MBTA Design Team[3] |
| | Stabilize any highly erosive soils with erosion control blankets and other stabilization methods, as necessary. | During construction | MBTA D/B Contractor[2] |
| | Reinforce slopes using a hydroseed mix with a resin base, native vegetation, or other approved methods. | During construction | MBTA D/B Contractor[2] |
| | Use dewatering controls, if necessary. | During construction | MBTA D/B Contractor[2] |
| | Install a gravel entrance at construction sites to prevent sediment from being tracked onto roadways and potentially discharged to surface waters. | During construction | MBTA D/B Contractor[2] |
| | Maintain construction equipment to prevent oil and fuel leaks and install catch basin protection as needed. | During construction | MBTA D/B Contractor[2] |
| Hazardous Materials | Consult with MassDEP to ensure planning and implementation of demolition and management of contaminated soils is consistent with applicable MassDEP regulations and recommendations. | During design and construction | MBTA Environmental Team with D/B Contractor[2, 4] |
| | Follow all protocols to adequately characterize, stockpile and dispose of materials encountered during construction. | During design and construction | MBTA D/B Contractor[2] |
| Outreach | Establishing a project construction office. | During construction | MBTA D/B Contractor[2] |
| | Establishing a Green Line Extension project Ombudsman position who would field all construction-period comments and complaints, coordinate with the cities, and respond to public concerns. | During construction | MBTA D/B Contractor[2] |
| | Establish a Construction Working Group to advise MassDOT and the MBTA. | During construction | MBTA D/B Contractor[2] |
| | Establish a project email address and 24-hour phone hotline for public concerns. | During construction | MBTA |
| | Provide frequent website updates of construction activities at www.mass.gov/greenlineextension | During construction | MassDOT/MBTA |
| | Host neighborhood construction kick-off meetings. | During construction | MBTA D/B Contractor[2] |
| | Produce quarterly construction updates. | During construction | MBTA D/B Contractor[2] |
| | Develop a business outreach plan to assist local businesses during construction. | During construction | MBTA D/B Contractor[2] |

1 MBTA PM/CM Team = Team selected by the MBTA to handle Program Management, Construction Management and oversight of Preliminary Engineering.
2 MBTA D/B Contractor = Contractor selected and coordinated by the MBTA to handle Design and Build phase of the project
3 MBTA Design Team = MBTA management team that oversees design and construction projects.
MBTA Environmental Team = MBTA Environmental Department Staff

# 8

# Section 4(f) Evaluation

This Section 4(f) Evaluation identifies properties protected under Section 4(f) of the U.S. DOT Act of 1966, as amended,[1] within the project study area. The information provided describes potential impacts to the Section 4(f) resources resulting from the Proposed Action, and alternatives and measures to minimize harm and mitigate unavoidable impacts to these Section 4(f) resources.

## 8.1 About the Project

The Proposed Action, as shown on Figure 1.1-1 and evaluated in this EA, includes:

- Extending Green Line service 3.4 miles north to Medford (the Medford Branch) within the existing MBTA Lowell Line commuter rail right-of-way, from a relocated Lechmere Station to College Avenue Station with intermediate stations at Washington Street, Lowell Street, Gilman Square, and Ball Square; and
- Extending Green Line service 0.9 miles west to Union Square (the Union Square Branch) in Somerville, within the existing MBTA Fitchburg Line commuter rail right-of-way, from the relocated Lechmere Station to a new station near Union Square.

Detailed analyses were conducted and alternative alignments, station sites, and environmental impacts have been evaluated for this EA. The Proposed Action was selected as the preferred alternative for its ability to: meet all of the project goals; provide the best balance of cost, ridership, and environmental impacts; be operationally practical; and generate a high number of new systemwide transit trips.

The Green Line Extension project is an initiative of the MassDOT and the MBTA to improve mobility, boost transit ridership, improve air quality, ensure equitable distribution of transit services, and support opportunities for smart growth initiatives and sustainable development in the project study area of Cambridge, Somerville, and

1 *Section 4(f) of the United States Department of Transportation Act of 1966* (Amended March 12, 2008 in 73 FR 13395; implemented at 23 U.S.C. 138 and recodified at 49 USC, Subtitle I, Section 303(c)). Available at: http://www.gpo.gov/fdsys/pkg/FR-2008-03-12/pdf/E8-4596.pdf

Medford. The project is required by the SIP and fulfills a longstanding commitment of the Central Artery/Tunnel project to increase public transit.

The Green Line Extension project would provide light rail transit beyond Cambridge's Lechmere Station, which is currently the only Green Line station north of the Charles River. The Proposed Action would serve the region's most densely populated communities that today are surrounded by, but are not directly served by, fixed-guideway transit. The residential densities are approximately 18,870 people per square mile in Somerville, 15,760 in Cambridge, and 6,850 in Medford.[2] Somerville is recognized as one of the most densely populated municipalities in the United States. In addition, approximately 60 percent of the residents of Cambridge, Somerville, and Medford live in state-defined environmental justice areas, which take up approximately 42.8 percent of the cities' combined area.[3]

Although MBTA commuter rail lines pass through the project study area, there are no rail transit stops within these communities. The project study area is currently served by bus transit only, and U.S. Census data (2000) indicates that approximately 26 percent of project study area households do not own a vehicle, which suggests a market for a higher level of transit service than exists today. Existing transit service within the project study area is currently offered by 15 MBTA bus routes with access to points within the project study area as well as to Boston, Arlington, Woburn, and Winchester. However, existing bus routes operate within the congested urban street network where intense automobile traffic hinders bus service and causes inefficient and unreliable transit service in the project study area.

The Green Line Extension project is needed to improve mobility and livability, particularly in transit-dependent and environmental justice communities. The Green Line Extension project enjoys community support throughout the project study area, where residents and businesses want better and expanded transportation access.

The Green Line Extension project offers benefits to the area, in that the Proposed Action would:

- Focus regional transportation investment in established environmental justice communities, connecting currently underserved residents to jobs and services in Boston and Cambridge and strengthening business and residential districts in the project study area.
- Improve transit travel times within the project study area by 13 to 17 minutes (compared to the No-Build Alternative) from the relocated Lechmere Station to Union Square or College Avenue, respectively.
- Offer a one-seat ride from the project study area into downtown Boston, eliminating the need for commuters to make the bus/rail transfer to the

2 U.S. Census Bureau, *Census 2000*. Available at http://www.census.gov
3 Environmental justice areas are defined by thresholds for income, minority populations, foreign-born populations, and English language proficiency. Therefore, most environmental justice areas contain a mix of environmental justice and non-environmental justice residents.

Green Line at the relocated Lechmere Station or to the MBTA's Orange and Red lines at other stations.

- Generate daily ridership at the project's seven stations of approximately 49,000 boardings and alightings by 2030, with approximately 92 percent of the new ridership is projected to take place in the project's opening year of 2019. The Green Line as a whole would also see an increase of 25,970 boardings, and the entire MBTA system would see an increase of 7,500 new daily linked transit trips as a result of the extended Green Line service.
- Substantially improve mobility and service quality for transit-dependent riders, with improved access (*i.e.*, service, travel time savings) to jobs or schools and health care facilities and provide universal access, meeting ADA standards at all stations.
- Be fully grade separated and principally constructed within existing MBTA commuter rail rights-of-way, which would enable light rail to serve pedestrian-oriented centers with minimal disruption to the surrounding community and with minimal property or neighborhood impacts.
- Maintain existing railroad operations while employing mitigation measures to reduce noise and vibration impacts, resulting in residential and retail areas that would experience reduced existing noise levels.
- Reduce daily VMT by 25,728, as compared to the No-Build Alternative, improving regional air quality and providing zero-emission transportation capacity for anticipated growth.
- Additional information on the Green Line Extension project is provided in Chapter 4, *Alternatives*, of this EA.

## 8.2 Section 4(f) Applicability

Section 4(f) of the U.S. DOT Act[4] provides protection for publicly owned parks, recreation areas, public school playgrounds, wildlife and waterfowl refuges, and historic properties or archeological sites on or eligible for listing on the National Register of Historic Places (the National Register). The DOT Act outlines Section 4(f) as follows:

> "The Secretary of Transportation shall cooperate and consult with the Secretaries of the Interior, Housing and Urban Development, and Agriculture, and with the States, in developing transportation plans and programs that include measures to maintain or enhance the natural beauty of lands crossed by transportation activities or facilities… The Secretary may approve a transportation program or project … requiring the use of publicly owned land of a public park, recreation area, or wildlife and waterfowl refuge of national, State, or local significance, or land of an historic site of

4 *Section 4(f) of the United States Department of Transportation Act of 1966* (Amended March 12, 2008 in 73 FR 13395; implemented at 23 U.S.C. 138 and recodified at 49 USC, Subtitle I, Section 303(c)). Available at: http://www.gpo.gov/fdsys/pkg/FR-2008-03-12/pdf/E8-4596.pdf

national, State, or local significance (as determined by Federal, State, or local officials having jurisdiction over the park, area, refuge, or site) only if:

- There is no prudent and feasible alternative to using that land; and
- The program or project includes all possible planning to minimize harm to the park, recreation area, wildlife and waterfowl refuge, or historic site resulting from the use."

Use of a Section 4(f) resource is defined[5] as:

- "When land is permanently incorporated into a transportation facility";
- "When there is a temporary occupancy of land that is adverse in terms of the statute's preservationist purposes…"; or
- "When there is a constructive use of land." "Constructive use occurs when the transportation project does not incorporate land from a Section 4(f) resource, but the project's proximity impacts are so severe that the protected activities, features, or attributes that qualify a resource for protection under Section 4(f) are substantially impaired. Substantial impairment occurs only when the protected activities, features, or attributes of the resource are substantially diminished."

## 8.3 Parks, Recreation Areas, and Wildlife and Waterfowl Refuges

Two public parks and two public recreation areas are located within the resource study area, as defined in Section 5.13, *Parks and Recreation Areas*. These sites are listed in Table 8.3-1 and depicted on Figures 5.1-1 through 5.1-9. These resources were identified using available GIS data and information provided by the municipalities of Somerville, Cambridge, and Medford. The existing parks and recreation areas within the resource study area are neither public school playgrounds nor wildlife and waterfowl refuges subject to Section 4(f).

### Table 8.3-1 Existing Parks and Recreation Areas within the Study Area

| Property | Location | Size (acres) | Ownership | Type of Property | Primary (Designated) Use of Property |
|---|---|---|---|---|---|
| Trum Playground | Cedar Street at Franey Road | 0.39 | City of Somerville | Public Recreation Area | Passive Recreation, Playground |
| Park at Somerville Junction | Centre Street at Woodbine Street | 0.50 | City of Somerville | Public Park | Passive Recreation, Picnic Areas, Running, Bicycling, Walking |
| Hoyt-Sullivan Playground | Central Street | 0.38 | City of Somerville | Public Recreation Area | Active Recreation, Playground, Basketball |
| Lechmere Canal Park | Edward Land Boulevard | 4.39 | City of Cambridge | Public Park | Passive Recreation, Picnic Areas, Running, Bicycling, Walking |

5 Ibid.

## 8.4 Historic Resources

Table 8.4-1 lists the 23 individual historic properties and six historic districts within the Proposed Action portion of the APE. The locations of these historic resources are depicted on Figures 5.15-1 through 5.15-9.

### Table 8.4-1 National Register Listed or Eligible Properties or Districts within the Area of Potential Effect

| Property | Map Identifier[1] | Address | Municipality | National Register Designation |
|---|---|---|---|---|
| **National Register Listed** | | | | |
| Charles River Basin Historic District | C | Charles River Basin | Cambridge | Listed |
| Somerville Multiple Resource Area Historic District | F | Various | Somerville | Listed |
| Samuel Ireland House | 68 | 117 Washington Street | Somerville | Listed |
| Central Library | 161-1 | 79 Highland Avenue | Somerville | Listed |
| Somerville City Hall | 162 | 93 Highland Avenue | Somerville | Listed |
| Susan Russell House | 195 | 58 Sycamore Street | Somerville | Listed |
| **National Register Eligible** | | | | |
| Central Hill Area Historic District | H | Highland Avenue Area | Somerville | Eligible[3] |
| Gilman Square Historic District | I | Gilman Square | Somerville | Eligible[3] |
| Stickney Subdivision Area Historic District | J | Dartmouth Street Area | Somerville | Eligible[3] |
| Powder House/Winter Hill Industrial Area Historic District | K | Vernon Street Area | Somerville | Eligible[3] |
| Lechmere Viaduct | 1 | East Cambridge | Boston and Cambridge | Eligible[2] |
| MBTA Lechmere Station | 2 | Lechmere Square | Cambridge | Eligible[3] |
| William L. Lockhart Coffin Factory Office | 11 | 199-201 Monsignor O'Brien Highway | Cambridge | Eligible[2] |
| John Morrell and Company Branch House | 12 | 221 Monsignor O'Brien Highway | Cambridge | Eligible[3] |
| Whitehead Metal Products Company | 13 | 225 Monsignor O'Brien Highway | Cambridge | Eligible[3] |
| Jackson and Newton Company | 18 | 51 McGrath Highway | Somerville | Eligible[3] |
| Buddy's Truck Stop/Sawin's Diner | 69 | 113 Washington Street | Somerville | Eligible[3] |
| McGrath Highway/Route 28 Bridge over B&M Railroad | 105 | McGrath Highway | Somerville | Eligible[2] |
| Hill-Michie Company Auto Garage | 130 | 295-297 Medford Street | Somerville | Eligible[3] |
| Litchfield Block | 136 | 247-251 Pearl Street | Somerville | Eligible[3] |
| Malta Temple/Signet Commandery #188 | 137 | 339-343 Medford Street | Somerville | Eligible[3] |
| Reid and Murdock Company Warehouse | 138 | 350 Medford Street | Somerville | Eligible[3] |
| Somerville High School & Superintendent's Office | 161-2 | 81 Highland Avenue | Somerville | Eligible[2] |
| Derby Desk Company | 206 | 20 Vernon Street | Somerville | Eligible[3] |
| Hillson Building | 280 | 693-701 Broadway | Somerville | Eligible[3] |
| Somerville Automobile Company | 288 | 664 Boston Avenue | Medford | Eligible[3] |
| Warner & Childs Division Factory Mill and Garage | 302<br>302.1 | 546-574 Boston Avenue | Medford | Eligible[3] |
| Tufts University, Bray Memorial Laboratory | 305 | 504 Boston Avenue | Medford | Eligible[3] |
| Tufts University, Commons Building/Curtis Hall | 307 | 474 Boston Avenue | Medford | Eligible[3] |

1 Figures 5.15-1 through 5.15-9. Number identifier indicates individual historic properties and letter identifier indicate historic districts.
2 Previously determined National Register-eligible by MHC.
3 Recommended National Register-eligible as part of the Green Line Extension Study.

## 8.5 Archeological Resources

Section 4(f) applies to all archeological sites that are listed or eligible for listing in the National Register and that warrant preservation in place.[6] There are no known archeological resources protected under Section 4(f) within the project APE. Two areas of archeological sensitivity were identified within the project APE, one at the Washington Street Station site and the second in the vicinity of the Option L maintenance and storage facility site. The Washington Street Station (formerly known as Brickbottom Station) was recently relocated to avoid potential impact to archeologically sensitive strata between Joy Street and the railroad right-of-way in Somerville known to previously contain mid to late nineteenth century worker housing. Subsurface investigations found that there is extensive fill and/or previously disturbed belowground soil contexts in the vicinity of the Option L maintenance and storage facility site, which makes it unlikely that intact archeological resources would be discovered in this location during construction.

The Proposed Action is not expected to impact archaeological resources. However, should any unidentified archeological resources be discovered during construction, MassDOT would ensure that appropriate notification and preservation procedures are followed, as stipulated in the MOA (Appendix G, *Memorandum of Agreement*). No other areas of archeological sensitivity were identified for the Green Line project APE because of the presence of extensive fill and/or previously disturbed belowground soil contexts.

## 8.6 Potential Impacts to Section 4(f) Resources

The Green Line Extension project plans were compared to park, recreation area, and historical site boundaries to determine if any permanent acquisition or temporary occupancy of land would be required. For determining constructive uses as defined by Section 4(f) noise or vibration impacts, access restrictions, and visual impacts were assessed to determine if these impacts would substantially impair the resource.

### 8.6.1 Parks and Recreation Areas

The Proposed Action would not use parks and recreation areas protected by Section 4(f). The Proposed Action would not require permanent land acquisition or temporary occupancy of any Section 4(f) park or recreation area. Three parks within

6 United States Department of Transportation, Federal Highway Administration. *23 Code of Federal Regulations, Part 774 – Parks, Recreation Areas, Wildlife and Waterfowl Refuges, and Historic Sites* (Section 4(f)). April 11, 2008. Available at: http://ecfr.gpoaccess.gov/

the project study area would experience a moderate increase in noise levels, prior to the installation of noise mitigation measures; these noise levels would not substantially impair the resource and would, therefore, not constitute a constructive use.

- **Trum Playground —** Sound levels would increase by 3.4 dBA, from 68.6 dBA [Leq] to 72.0 dBA [Leq]. Without mitigation measures in place, Trum Playground would experience these impacts 36 feet from the commuter train track centerline. According to the FTA's noise criteria, Trum Playground is a Category 3 land use.[7]
- **Hoyt-Sullivan Playground —** Direct existing sound level measurements were not made at the Hoyt-Sullivan Playground, but measurements were made at adjacent properties and modeling indicates that sound levels would increase by 1.7 dBA. Residences on Sycamore Street near Richdale Avenue, adjacent to the Hoyt-Sullivan Playground, would realize sound level increases from 71.2 dBA [Leq] to 72.9 dBA [Leq]; noise level increases at Hoyt-Sullivan Playground would be similar. Without mitigation measures in place, similar increases would be expected at Hoyt-Sullivan Playground. This site is also considered a Category 3 land use. Because the property is primarily designated for active recreation, this location is not considered sensitive to noise.
- **The Park at Somerville Junction —** Direct existing sound level measurements were also not made at the Park at Somerville Junction, but measurements were made at adjacent properties and modeling indicates that sound levels would increase by 1.5 dBA. Sound levels at the Visiting Nurses Assisted Living residences, adjacent to the Park at Somerville Junction, would increase from 70.9 dBA [Leq] to 72.4 dBA [Leq]. Without mitigation, similar increases would be expected at the Park at Somerville Junction. The Park at Somerville Junction is also considered a Category 3 land use.

The predicted noise levels at these parks are considered compatible with outdoor recreation[8] and would not be so severe that the activities at the parks would be substantially impaired; therefore, no Section 4(f) use of these parklands would occur. Specifically, noise barrier mitigation at Trum Playground and near the Park at Somerville Junction and the Hoyt-Sullivan Playground would effectively eliminate any noise impacts to these resources to a condition equivalent to, or better than, that which would occur if the project were not built.

No other Section 4(f) parks or recreation area resources would be impaired by noise from the Proposed Action. There would also be no substantive increases in vibration

7 Category 3 land use is defined as institutional land uses with primarily daytime and evening use. This category includes schools, libraries, theaters, and churches where it is important to avoid interference with such activities as speech, meditation, and concentration on reading material. Other places for meditation or study associated with cemeteries, monuments, museums, campgrounds and recreational facilities can also be considered to be in this category. Certain historical sites and parks are also included in Category 3.

8 Harris Miller Miller and Hanson, Inc. *MBTA Green Line Extension Noise and Vibration Technical Report*, *Environmental Assessment*, August 2011.

levels at Section 4(f) parks or recreation areas, and therefore no constructive use of these facilities from increases in vibration levels.

## 8.6.2 Historic Properties

The Proposed Action would require the use of (the demolition of historic properties located on existing transportation property or the permanent acquisition of new land for transportation purposes) the following four National Register-eligible properties:

- The Lechmere Viaduct in Boston and Cambridge;
- The Lechmere Station in Cambridge;
- The Somerville Automobile Company in Medford and Somerville; and
- The Reid and Murdock Company Warehouse, located within the National Register-eligible Gilman Square Historic District in Somerville.

### Lechmere Viaduct

The Proposed Action requires the partial demolition of the existing steel portion of the Lechmere Viaduct (Figure 5.15-1, Map ID 1). The Lechmere Viaduct is eligible for listing on the National Register. Approximately 450 feet of the existing steel viaduct (the segment crossing over the Monsignor O'Brien Highway/Route 28) would be demolished and a new elevated structure would be built as a guideway connecting the historic viaduct with the proposed Green Line Extension tracks. This would result in a Section 4(f) use because it would result in the demolition of the historic resource, which is located on land currently used for transportation.

#### Avoidance Options

The demolition of the Lechmere Viaduct is unavoidable as there are no practicable alternatives to build the Proposed Action. In order to support the Green Line Extension, the viaduct must be located on the northeast side of Monsignor O'Brien Highway/Route 28, while it is currently located on the southwest side of the highway. The viaduct must be demolished in order to accommodate the new alignment in order to connect the existing Green Line tracks with the MBTA Fitchburg Line and MBTA Lowell Line rights-of-way.

#### Measures to Minimize Harm and Mitigate Impacts

The Proposed Action has been designed to minimize the extent of demolition of the existing Lechmere Viaduct to the steel portion over the Monsignor O'Brien Highway/Route 28 in Cambridge. The removal of the Lechmere Viaduct over the highway would be a positive visual effect to the neighborhood in that it would remove an overhead visual obstruction. As design advances, every effort will be made to further minimize impacts to this portion of the Lechmere Viaduct, as part of the Proposed Action.

The MBTA will ensure that the design plans and construction specifications that affect the demolition and realignment of the Lechmere Viaduct are context-sensitive and are submitted to the MHC, the relevant historic commissions, and the Design Working Group prior to construction for review and comment.

Prior to any demolition or construction activities, archival photographic and written documentation of this segment of the Lechmere Viaduct will be prepared by a qualified historic preservation consultant, in consultation with the MHC and relevant historical commissions. The archival documentation will be submitted to the appropriate repositories and relevant historical commissions.

## Lechmere Station

The Proposed Action requires the abandonment and demolition of the existing Lechmere Station (Figure 5.15-1, Map ID 2). Lechmere Station is eligible for listing on the National Register. The existing Lechmere Station would be demolished and the land cleared. Lechmere Station would be relocated to the northeast side of Monsignor O'Brien Highway/Route 28, between East Street and Water Street, in order to connect the existing Green Line tracks within the MBTA Fitchburg Line and MBTA Lowell Line rights-of-way. Leaving the Lechmere Station in its current location would preclude the ability to utilize existing commuter rail rights-of-way to extend the Green Line. The loss of the station would result in a Section 4(f) use because it would result in the demolition of this historic resource, which is located on land currently used for transportation.

The Proposed Action would extend the Lechmere Viaduct approximately 1,000 feet to the north and incorporate a new Lechmere Station on the new elevated structure (Figure 8.6-1). The proposed station would be a two-level, multimodal, ADA-accessible station that would accommodate both rail and bus operations. The Proposed Action would provide interim train storage, bicycle accommodations, parking, and off-site roadway improvements including new roadways, roadway widening at existing signalized intersections, and new signals. The Proposed Action would provide the same or improved functions as the existing Lechmere Station and allow future ridership expansion and operations.

It is not feasible to extend the Green Line to Medford and Somerville while retaining Lechmere Station in its current location. The existing station is on the southwest side of the Monsignor O'Brien Highway/Route 28, while the railroad rights-of-way that the Green Line Extension must use are on the northeast side of the highway. The use of this Section 4(f) resource, therefore, cannot be avoided.

The relocated Lechmere Station has been selected for the Proposed Action because it provides a station in the Lechmere Square area that is much more cost effective than other options (as described below). This location would not result in substantial community impacts through the acquisition of multiple residential and commercial businesses that would result from the other options evaluated. The relocated Lechmere Station satisfies the Purpose and Need of the project and is a feasible and prudent option.

## Avoidance Options

The following paragraphs present the avoidance options considered for providing a transit station at Lechmere, the southern terminus of the Green Line Extension project study area. Table 8.6-1 provides a comparison of the Lechmere Station options.

### Option 1: Retain Existing Lechmere Station with an At-Grade Green Line Extension

This option evaluated retaining the existing Lechmere Station and the Lechmere Viaduct in its current location by extending the Green Line at-grade from the existing station to the railroad right-of-way in the Inner Belt Area. The existing at-grade station is on the west side of the Monsignor O'Brien Highway/Route 28. As shown in Figure 8.6-1, there are no exclusive transit rights-of-way on the southwest side of the highway between the existing Lechmere Station and the MBTA Fitchburg Line right-of-way, a distance of 2,700 feet. The intervening area is entirely developed with a range of uses including the Cambridge Fire Department, residences, commercial buildings, a public recreational property (the Gore Field and Playground), and a large commercial/retail mall.

Two bridge structures would have to be constructed to connect the at-grade Green Line Extension from its current endpoint to the MBTA Lowell Line railroad right-of-way at Washington Street. The alignment would extend along the west side of Monsignor O'Brien Highway/Route 28 to the mall, where it would curve to the east and cross over McGrath Highway on a bridge to a 100-foot long retained fill section and then it would cross over the MBTA Fitchburg Line on a second structure.

Extending the Green Line along the southwest side of the Monsignor O'Brien Highway would impact 11 residential and 15 commercial properties, and would increase the cost of the Proposed Action by approximately $140 million in 2011 dollars. More than half of that cost differential is attributed to land acquisition, building demolition, and site cleanup costs for the properties acquired. This option would also result in the use of a Section 4(f) property, a public recreation area (Gore Field), and therefore would also not avoid the use of Section 4(f) properties.

Given the extensive impacts to Cambridge and Somerville residences, a large commercial/retail mall, and high costs, this at-grade option is not prudent.

Option 2: Retain Existing Lechmere Station with a Tunnel Extension

This option evaluated retaining the existing Lechmere Station in its current location by extending the Green Line below grade, from the existing station and following essentially the same alignment as for Option 1 (Figure 8.6-1).

Extending the Green Line along the southwest side of the Monsignor O'Brien Highway/Route 28 in twin bored tunnels would reduce impacts to 10 residential and four commercial properties, but would increase the cost of the Proposed Action by $315 million in 2011 dollars, making it infeasible within the fiscal constraints of the Commonwealth's budget for the project.

The impacts to properties would be great on the south tunnel approach (where an open "boat section" would be required to transition from the surface to the tunnel). The tunnel option would require a 1,000-foot long transition boat section starting at the existing at-grade station heading north. Assuming the transition would follow a maximum profile gradient of 4 percent, a 1,000-foot section would be required to attain a tunnel depth of 40 feet (approximately twice the bored tunnel diameter). Once the tunnel reaches its maximum depth, it would curve to the northeast and pass under the highway, below commercial properties and then under the MBTA Fitchburg Line right-of-way (a distance of approximately 1,000 feet). On the north side of the MBTA Fitchburg Line right-of-way, the tunnel would rise to the existing railroad grade south of Washington Street through a 1,000-foot transition/boat section.

Given the extensive impacts to Cambridge and Somerville residences and exceptionally high structural costs, the tunnel option is not prudent.

Option 3: Retain Existing Lechmere Station with an At-Grade Green Line Extension within the Median of Monsignor O'Brien Highway

This option evaluated placing the Green Line Extension within the Monsignor O'Brien Highway/Route 28 right-of-way between the existing Lechmere Station and the MBTA Fitchburg Line rail right-of-way. This option would retain the existing Lechmere Station in its current location by extending the Green Line at-grade from the existing station to Monsignor O'Brien Highway. The existing at-grade Lechmere Station is on the west side of the Monsignor O'Brien Highway. As shown in Figure 8.6-1, this would require widening the roadway right-of-way by 30 feet between the existing Lechmere Station and the MBTA Fitchburg Line right-of-way, a distance of approximately 2,700 feet, to accommodate the double tracks within the median. Because McGrath Highway currently crosses the MBTA Fitchburg Line on a bridge, the bridge would have to be widened.

The properties abutting Monsignor O'Brien Highway are developed with a range of residential and commercial uses including a public recreational property (the Gore Field and Playground) and a large commercial/retail mall. Approximately 16 of these buildings would be demolished for the road widening. Similar to Option 1, this option would have 25 residential and commercial property impacts and would increase the cost of the Proposed Action by $130 million in 2011 dollars.

Furthermore, the McGrath Highway Bridge over the MBTA Fitchburg Line would have to be widened to accommodate the new tracks. From the bridge, the Green Line Extension would curve in northeasterly direction across several Brickbottom area properties where it would rise within a 700-foot long retained fill section to the existing rail right-of-way south of Washington Street.

This option would increase the capital costs for the project by approximately $130 million in 2011 dollars. More than half of that cost differential is attributed to land acquisition, building demolition, and site cleanup costs within properties north of Lechmere Station, along Monsignor O'Brien Highway/Route 28, and through the Brickbottom area.

Running the Green Line Extension within the Monsignor O'Brien Highway/Route 28 median would require additional traffic signals and traffic controls along this already congested roadway. Adding Green Line vehicles to this corridor would exacerbate capacity problems of this roadway, particularly during peak hours.

Given the extensive impacts to Cambridge residences, industrial/commercial properties in Somerville, Monsignor O'Brien Highway/Route 28 traffic, and high costs, the in-street option is not prudent.

Summary of Lechmere Station Options

Table 8.6-1 summarizes the options considered for the relocated Lechmere Station.

Table 8.6-1 Lechmere Station - Summary of Options

| Issue | Option 1: Retain Existing Station with At-grade Green Line Extension | Option 2: Retain Existing Station with Tunnel Extension | Option 3: Retain Existing Station with At-grade Extension within Monsignor O'Brien Highway Median | Proposed Action: Relocate Lechmere Station |
|---|---|---|---|---|
| Meets Purpose and Need | Partially: Causes substantial community disruption | Partially: Causes substantial community disruption | Partially: Causes substantial community disruption | Yes |
| Feasibility | Feasible | Feasible | Feasible | Feasible |
| Community Disruption | Substantial Impact<br>11 residential and<br>15 commercial displacements | Substantial Impact<br>10 residential and<br>4 commercial displacements | Substantial Impact<br>25 residential and commercial displacements | No |
| Cost (in millions of 2011 dollars) | Additional $140 over Proposed Action | Additional $315 over Proposed Action | Additional $130 over Proposed Action | $20.6 |
| Impact to Section 4(f) Resources | Gore Field (Public Recreation Area) | None | Gore Field (Public Recreation Area) | Use of Lechmere Station and portion of Lechmere Viaduct |
| Prudent | No: Results in substantial increase in construction costs | No: Results in substantial increase in construction costs | No: Results in substantial increase in construction costs | Yes |

### Measures to Minimize Harm and Mitigate Impacts

As design advances, every effort will be made to further minimize impacts to the property during the demolition of the Lechmere Station. The MBTA will ensure that the design plans and construction specifications for the proposed Lechmere Station are context-sensitive and are submitted to the MHC, the local historic commissions, and the Design Working Group prior to construction for review and comment.

Prior to any demolition or construction activities, archival photographic and written documentation of the existing MBTA Lechmere Station will be prepared by a qualified historic preservation consultant, in consultation with the MHC and relevant historical commissions. The archival documentation will be submitted to the appropriate repositories and local historical commissions.

The MBTA Design Department, following MBTA design protocol review, will develop interpretive displays in consultation with the FTA, the MHC and relevant historical commissions, to be located at the site of the proposed relocated Lechmere Station. This interpretative display will discuss the history of Lechmere Station, the adjacent Lechmere Viaduct, elevated railway, and their appropriate historic contexts using text, photographic images, and maps.

## Somerville Automobile Company

The Proposed Action requires the acquisition and demolition of the National Register-eligible Somerville Automobile Company at 662 and 664 Boston Avenue in Medford and Somerville (Figure 5.15-7, Map ID 288) for the construction of a new station at Ball Square. The acquisition of the Somerville Automobile Company property and the demolition of the historic building would constitute a use under Section 4(f) because it would result in the demolition of this historic resource and because it would require the use of the property.

The Ball Square area of Somerville is at the intersection of Broadway and Boston Avenue. Ball Square is a densely developed residential neighborhood interspersed with light industrial, commercial, and public recreational facilities. The MBTA Lowell Line is parallel to Boston Avenue, one block east (Figure 8.6-2). The Proposed Action has the benefit of being within the immediate Ball Square area and would not require the acquisition of any residential property. The Proposed Action does require the use (acquisition and demolition) of the National Register-eligible Somerville Automobile Company at 662 and 664 Boston Avenue in Medford and Somerville (currently occupied by a private bowling club and an auto repair garage).

While using this site for the Ball Square Station requires the use of a Section 4(f) property, the impact of the required property acquisitions to this low-income/ minority community would be minor. Given the ideal location of the proposed station in the heart of Ball Square and the lack of substantial community disruption within a low-income/minority community, constructing the Ball Square Station at the southeast quadrant of Ball Square is feasible and prudent.

### Avoidance Options

The following paragraphs describe the avoidance options considered for a station within the Ball Square area. Table 8.6-2 provides a comparison of the Ball Square Station options. The options evaluate station locations to avoid use of the National Register-eligible Somerville Automobile Company building at 662 and 664 Boston Avenue in Medford and Somerville.

#### No-Build Option

The No-Build option consists of not constructing a station at Ball Square. The No-Build option is not prudent. Construction of a station at Ball Square (as well all other stations) was determined through a station and alignment selection process (Appendix H, *State and Alignment Selection Process*) in which four general categories of station selection criteria were used to evaluate key considerations at each alternative station site. The criteria were used to qualitatively assess each of the proposed station sites and assist in the selection of the preferred station site for each designated neighborhood node. The general categories of criteria include station access, transit operations, land use compatibility, and costs. The station selection process also included substantial public input through public workshops and coordination with officials.

The one-half mile radius zone around the Ball Square area is a densely developed residential neighborhood of single-family, two-family, and three-family homes within an environmental justice community. A commercial strip along Broadway includes several restaurants and retail stores. Several schools and parks are also within the Ball Square area. MBTA Bus Routes 80 and 89 travel on Broadway at the immediate station site. Daily ridership at this station is anticipated to be 1,850 boardings (projected to the year 2030).

The No-Build option is not prudent. Not constructing a station in Ball Square area would result in the loss of anticipated transit access (with related air quality improvements) within an environmental justice community (Figure 5.4-1).

#### Option 1: Station at the Southwest Quadrant of Ball Square

Option 1, Ball Square Station at the southwest quadrant of Ball Square, consists of station construction along the east side of Boston Avenue immediately south of Broadway (Figure 8.6-2). This option has the benefit of being within the immediate Ball Square area and would not require the use of any Section 4(f) properties. However, this option would require the acquisition of approximately 13 residential buildings along the east side of Boston Avenue, resulting in substantial community disruption within this low-income/minority community. These properties are primarily multi-family buildings. The minimization of private property acquisitions, particularly residential property, is a stated goal of the Green Line Extension project.

Given the substantial community disruption resulting from the acquisition of approximately 13 single and multi-family residential properties within a low-income/minority community, Option 1, Ball Square Station at the southwest quadrant of Ball Square, is not prudent.

#### Option 2: Station at the Southeast Quadrant of Ball Square

Option 2, Ball Square Station at the southeast quadrant of Ball Square, consists of station construction along the east side of MBTA Lowell Line immediately south of Broadway (Figure 8.6-2). This option has the benefit of being within the immediate Ball Square area and would not require the use of any Section 4(f) properties. However, this option would require the acquisition of a gas station/convenience store and other commercial properties, a chapter house of the Disabled American Veterans (DAV), and seven residential houses. These numerous property acquisitions would result in substantial community disruption within this low-income/minority community. The residential properties are primarily multi-family buildings. The minimization of private property acquisitions, particularly residential property, is a stated goal of the Green Line Extension project.

Given the substantial community disruption resulting from the acquisition of approximately two commercial properties, a DAV meeting house and seven single and multi-family residential properties within a low-income/minority community, Option 2, Ball Square Station at the southeast quadrant of Ball Square, is not prudent.

Option 3: Station at the Northeast Quadrant of Ball Square

Option 3, Ball Square Station at the northeast quadrant of Ball Square, consists of station construction along the east side of the MBTA Lowell Line Boston Avenue immediately north of Broadway (Figure 8.6-2). This option has the benefit of being within the immediate Ball Square area and would not require the use of any Section 4(f) properties. However, this option would require the acquisition of a large medical office building (the Ball Square Medical Building, a primary care and family medicine provider), a multi-unit apartment building, three multi-unit residential buildings and a commercial property. These property acquisitions would cause substantial community disruption within this low-income/minority community. The minimization of private property acquisitions, particularly residential property, is a stated goal of the Green Line Extension project.

Given the substantial community disruption resulting from the acquisition of a commercial property, a primary care medical facility, and three multi-family residential properties within a low-income/minority community, Option 3, Ball Square Station at the northeast quadrant of Ball Square, is not prudent.

Option 4: Station at the Intersection of Boston Avenue and Harvard Street

Option 4, Ball Square Station at the intersection of Boston Avenue and Harvard Street, consists of station construction along the east side of Boston Avenue and south of Harvard Street (Figure 8.6-2). This option has the benefit of not requiring the use of any Section 4(f) properties.

This location is approximately 1,200 feet north of Ball Square (generally considered the intersection of Broadway and Boston Avenue). Ball Square is one of the neighborhood nodes selected through the 2005 *Beyond Lechmere* major investment study/alternatives analysis and the 2009 *Station and Alignment Selection Analysis* (provided in Appendix H of this EA) prepared for the Green Line Extension project. MBTA bus routes travel along Broadway, providing direct access to Ball Square. Passengers originating at Ball Square would have to walk more than 1,200 feet to reach the station. This distance would discourage use of the station, particularly for disabled or elderly passengers.

Further, this option would require the acquisition of a gas station, a fuel service company, and eight residential condominiums along the east side of Boston Avenue. These property acquisitions would cause modest community disruption within this low-income/minority community. The acquisition of private property, particularly residential property, is contrary to the stated goal of the Green Line Extension project.

Given the unacceptable distance of the station to Ball Square, lack of direct bus access, and the modest community disruption resulting from the acquisition of several commercial and residential properties within a low-income/minority community, Option 4, Ball Square Station at the intersection of Boston Avenue and Harvard Street, is not prudent.

Summary of Ball Square Station Options

Table 8.6-2 summarizes the options considered for the Ball Square Station.

Table 8.6-2 Ball Square Station – Summary of Options

| Issue | No-Build Option: | Option 1: Ball Square Station at Southwest Quadrant of Ball Square | Option 2: Ball Square Station at Southeast Quadrant of Ball Square | Option 3: Ball Square Station at Northeast Quadrant of Ball Square | Option 4: Ball Square Station at Intersection of Boston Avenue and Harvard Street | Proposed Action: Ball Square Station at Northwest Quadrant of Ball Square |
|---|---|---|---|---|---|---|
| Meets Purpose and Need | No | Partially: Causes substantial community disruption | Partially: Causes substantial community disruption | Partially: Causes substantial community disruption | Partially: Causes substantial community disruption. Station not located directly in Ball Square | Yes |
| Feasibility | Feasible | Feasible | Feasible | Feasible | Feasible | Feasible |
| Community Disruption | No | Substantial Impact 13 residential displacements | Substantial Impact 7 residential and additional commercial displacements (see below) | Substantial Impact 3 multi-unit residential properties and additional commercial displacements (see below) | Substantial Impact 8 residential condominiums and additional commercial displacements (see below) | Minor Impact 2 commercial property acquisitions |
| Cost (in millions of 2011 dollars) | $0 | Station costs (approx. $12.0) plus acquisition of 13 residential properties | Station costs (approx. $12.0) plus acquisition of gas station, other commercial properties, and 7 residential properties | Station costs (approx. $12.0) plus acquisition of medical office building, two commercial properties, apartment building, and 3 multi-unit residential properties | Station costs (approx. $12.0) plus acquisition of gas station, fuel co. and 8 residential condominiums | Station costs (approx. $12.0) plus acquisition of 2 commercial properties |
| Impact to Section 4(f) Resources | None | None | None | None | None | Demolition of National Register-eligible Somerville Automobile Company |
| Prudent | No: Does not achieve project Purpose and Need | No: Results in substantial impact to minority or low-income populations | No: Results in substantial impact to minority or low-income populations | No: Results in substantial impact to minority or low-income populations | No: Results in substantial impact to minority or low-income populations | Yes |

## Measures to Minimize Harm and Mitigate Impacts

The Proposed Action has been designed to minimize the extent of property acquisition necessary to construct the Ball Square Station. The footprint of accessible station features (such as the one-way pickup/drop-off area) has been designed to lessen impacts to the property. As design advances, every effort will be made to further minimize impacts to the property.

The MBTA will ensure that the design plans and construction specifications that affect the Somerville Automobile Company Building are context-sensitive and are submitted to the MHC, the local historic commissions, and the Design Working Group prior to construction for review and comment.

Prior to any demolition or construction activities, archival photographic and written documentation of the Somerville Automobile Company Building will be prepared by a qualified historic preservation consultant, in consultation with the MHC and relevant historical commissions. The archival documentation will be submitted to the appropriate repositories and local historical commissions.

The MBTA Design Department, following MBTA design protocol review, will develop interpretive displays, in consultation with the FTA, the MHC and relevant historical commissions, to be located at the site of the proposed Ball Square Station. This interpretative display will discuss the history of the surrounding Medford/Somerville communities, the Somerville Automobile Company Building, and the role that the automobile and streetcar in general contributed to the development of the area.

## Reid and Murdock Company Warehouse within Gilman Square Historic District

The Proposed Action requires a partial land taking from the National Register-eligible Reid and Murdock Company Warehouse property at 350 Medford Street in Somerville (Figure 5.15-5, Map ID 138) for the construction of a new station at Gilman Square. The Reid and Murdock Company Warehouse is a contributing element to the National Register-eligible Gilman Square Historic District.

The Proposed Action would require the use (partial acquisition and demolition) of the currently vacant, National Register-eligible Reid and Murdock Company Warehouse (Figure 8.6-3). Use of this historic property includes the partial acquisition of 22,404 square feet (adjacent parking area and demolition of a non-contributing railroad loading dock at the rear [south] of the building) of the 48,296-square foot parcel. The Proposed Action would also result in the loss of access to a three-bay loading dock southeast of the building. A portion of this property would be permanently acquired for transportation use, and therefore, would be a Section 4(f) use. The historic building would not be demolished and would remain available for future redevelopment/rehabilitation opportunities, by others.

The Proposed Action is prudent because the historic structure would be retained, would cause the least amount of community disruption among all considered options, and have the lowest cost among all the options.

### Avoidance Options

The project team evaluated alternatives at the Gilman Square Station to avoid the need to partially acquire the property occupied by the National Register-eligible Reid and Murdock Company Warehouse. The following sections describe options evaluated for station locations to avoid use of the National Register-eligible Reid and Murdock Company Warehouse building at 350 Medford Street in Somerville. Table 8.6-3 summarizes the comparison of the Gilman Square Station options.

Gilman Square Station is proposed near the intersection of Medford Street and Pearl Street, on the opposite side of the tracks from the Somerville High School and the Somerville City Center (which includes Somerville City Hall and the Somerville Public Library). Businesses extend from the station along Medford Street and Pearl Street at the station, and are also along Highland Avenue south and west of the station. The station is surrounded by multi-family residential areas.

### No-Build Option

The No-Build option consists of not constructing a station at Gilman Square. The No-Build option is not prudent. Constructing a station at Gilman Square (as well all other stations) was determined through the *Station and Alignment Selection Analysis* (provided in Appendix H of this EA), as previously discussed.

The one-half mile radius zone around the site is comprised of mostly dense, multi-family residential neighborhoods, two-family homes, and triple-decker homes. The housing density is the highest along the corridor, reflecting the number of low- and mid-rise apartment buildings within walking distance of the station. Several schools and the Central Street Health Center are located within the one-half mile radius. MBTA Bus Route 80 travels in the vicinity of the proposed station site. Daily ridership at this station is anticipated to be the second highest of all Green Line Extension stations at 3,930 boardings (projected to the year 2030).

The No-Build option is not prudent. Not constructing a station in the Gilman Square area would result in the loss of anticipated transit ridership and access (with related air quality improvements) within an environmental justice community.

### Option 1: Station at Walnut Street

Option 1, Station at Walnut Street, would be on a recently designated public municipal park, Edward L. Leathers Community Park, adjacent to the MBTA right-of-way to the north of Walnut Street (Figure 8.6-3). A station at this site, located on the eastern side of the tracks would provide pedestrian access from the Walnut Street Bridge over the MBTA Lowell Commuter Rail Line and from Walnut Street at a lower level to address the steep profile grades along School Street. Vehicular access for station pickup/drop-off would be directly from Walnut Street, which is not desirable because of the limited sight distance due to the curvature and steep grade of the road. Overall land acquisition costs for this option would be approximately $4 million in 2011 dollars (approximately $2 million more than the Proposed Action).

The location of the platform for Option 1 does not meet the MBTA's criteria for station and platform siting. Specifically, the MBTA requires a 300-foot long tangent section of track for locating a station platform. This design criterion is preferred for light rail operations and to safely accommodate ADA accessibility within the station. The section of track south of Medford Street is curved, blocking visibility of the train engineer on the inbound track and would require that all trains operate at 10 mph in order to accommodate level boarding.

Further, in order to accommodate even this less than optimal design, the adjacent commuter rail tracks would have to shift approximately 20 feet to the east to accommodate the proposed Green Line platform. Shifting the commuter rail tracks 20 feet to the east would require land acquisition from 11 residential properties (two full and nine partial) and one commercial property along Gilman Street. In addition, the recently designated park would need to be acquired for the station site, which would constitute a Section 4(f) use. An additional detriment of the shift of the commuter rail and resulting land acquisitions is that the noise barriers proposed between the MBTA line and the Gilman Street neighborhood would be constructed approximately 20 feet farther east, extremely close to the existing homes.

Given the inability of this station site to meet MBTA's criteria, the challenges associated with providing vehicular and pedestrian access, and the need to acquire additional property including the use of a Section 4(f) property, Option 1, Station at Walnut Street, is not prudent.

#### Option 2: Station at Montrose Street

Option 2, Station at Montrose Street, would be adjacent to the MBTA right-of-way at the corner of School Street and Montrose Street in a densely developed area currently occupied by residential homes (Figure 8.6-3).

This site is not desirable for a transit station for several reasons. Given the steep profile grades along School Street, compliance with ADA accessibility requirements would be poor. Vehicular access for station pickup/drop-off would be directly from Montrose Street. This is also not desirable because Montrose Street is a narrow one-way northbound street. Overall land acquisition costs for this option would be approximately $5 million in 2011 dollars (approximately $3 million more than the Proposed Action) and there would be an impact to six residential buildings.

The site of the Option 2 station is currently occupied by residential properties. This option would be more disruptive to the other nearby homes as compared to Option 4, as it would substantially increase vehicular and pedestrian traffic along Montrose Street.

Given the challenges associated with providing safe vehicular and pedestrian access, the need to acquire residential properties and higher cost, Option 2, Station at Montrose Street, is not prudent.

Option 3: Station at Richdale Avenue

Option 3, Station at Richdale Avenue, would be proposed adjacent to the MBTA right-of-way at the corner of School Street and Richdale Avenue (Figure 8.6-3) in an area currently occupied by commercial and residential properties. This site is not desirable for a transit station for several reasons. Given the steep profile grades along School Street, compliance with ADA accessibility requirements would be poor. Vehicular access for station pickup/drop-off would be directly from Richdale Avenue. This is not desirable because Richdale Avenue is a narrow one-way street. Overall land acquisition costs for this option would be approximately $4 million in 2011 dollars (approximately $2 million more than the Proposed Action) and there would be an impact to four residential buildings and one commercial building.

The site of the Option 3 station is currently occupied by residential and commercial properties and would be more disruptive to the nearby homes and businesses as compared to Option 4. It would substantially increase vehicular and pedestrian traffic along Richdale Avenue.

Given the challenges associated with providing safe vehicular and pedestrian access, the need to acquire residential and commercial properties and higher cost, Option 3, Station at Richdale Avenue, is not prudent.

Option 4: Station at the NSTAR Substation

Under this option, the Gilman Square Station would be located in the same location as the existing NSTAR substation. The existing substation would have to be relocated north of its current location within the same parcel. An access road would have to be constructed between School Street and Medford Street to provide access for the relocated substation and an accessible pickup/drop-off for the Gilman Square Station. The access road would have to be 20 to 24 feet wide to accommodate the Community Path as a shared use. The Gilman Square Station, the NSTAR substation, and the roadway would be constructed at the level of School Street on retained fill.

For this option, approximately 0.5 acres of land would have to be acquired from the Somerville City Center complex, which contains the National Register-eligible Somerville High School and Superintendent's Office building, the National Register-eligible Somerville City Hall, and the National Register-listed Central Library. These resources are also within the National Register-eligible Central Hill Area Historic District. Permanent acquisition of this land for transportation purposes would be considered a Section 4(f) use. In addition, a pedestrian bridge would be required to connect the residential community east of Medford Street to the new station. The construction of a pedestrian bridge would still require partial acquisition of the 350 Medford Street parking lot (a Section 4(f) use).

Overall land acquisition costs for the City property would be $1 million less than the Proposed Action but costs for fill and retaining walls would add approximately $2 million. With relocation of the substation the overall station cost would be $13 million in 2011 dollars over the Proposed Action.

Given the acquisition impacts to the substation and use of adjacent Section 4(f) resources, in addition to higher cost, Option 4, Station at the NSTAR Substation, is not prudent.

Summary of Gilman Square Station Options

Table 8.6-3 summarizes the options considered for the Gilman Square Station.

Table 8.6-3 Gilman Square Station - Summary of Options

| Issue | No-Build Option | Option 1: Station at Walnut Street | Option 2: Station at Montrose Street | Option 3: Station at Richdale Avenue | Option 4: Station at NSTAR Substation | Proposed Action: Station at 350 Medford Street – Partial Acquisition |
|---|---|---|---|---|---|---|
| Meets Purpose and Need | No | No: Does not fully meet MBTA's design criteria and causes substantial community disruption | Partially: Causes substantial community disruption and difficulties in meeting ADA requirements | Partially: Causes substantial community disruption and difficulties in meeting ADA requirements | Partially: Causes community access issues and difficulties in meeting ADA requirements | Yes |
| Feasibility | Feasible | Feasible | Feasible | Feasible | Feasible | Feasible |
| Community Disruption | No | Substantial impact to 11 residential (2 full and 9 partial), 1 commercial and 1 city-owned property | Substantial impact to 6 residential properties | Substantial impact to 4 residential properties and 1 commercial property | Impacts to substation, municipal land and historic properties and historic district | No |
| Cost (in millions of 2011 dollars) | $ 0 | Additional $2.0 over the Proposed Action | Additional $3.0 over the Proposed Action | Additional $2.0 over the Proposed Action | Additional $13.0 over the Proposed Action | $14.0 |
| Impact to Section 4(f) Resources | No | Yes: Use of recently designated municipal park | No | No | Yes: Use of land from historic properties and historic district | Yes: Partial loss of adjacent parking area and non-contributing historic element. Access to 3-bay garage would be blocked. Historic structure would remain for future redevelopment. |
| Prudent | No: Does not achieve project Purpose and Need | No: Results in increase in construction costs, use of Section 4(f) property and disruption to residential community | No: Results in increase in construction costs, impact and disruption to minority or low-income community | No: Results in increase in construction costs and disruption to residential community | No: Would result in use of Section 4(f) properties, increase in construction costs | Yes |

### Measures to Minimize Harm and Mitigate Impacts

The Proposed Action has been designed to minimize the extent of property acquisition necessary to construct the Gilman Square Station from the entire 48,296-square foot Reid and Murdock parcel to only partial acquisition of the parking area and a railroad loading dock at the rear [south] of the building (22,404 square feet). The partial acquisition allows the historic building to remain for potential future development (by others). In addition, clearances have been reduced between tracks to minimize impacts to the property. As design advances, every effort will be made to further minimize impacts to the property.

The MBTA will ensure that the design plans and construction specifications that affect the Reid and Murdock Company Warehouse Building (located within the Gilman Square Historic District) are context-sensitive and are submitted to the MHC, the local historic commissions, and the Design Working Group prior to construction for review and comment.

## 8.7 Findings

Based upon the analysis described above, there are no feasible and prudent alternatives to avoid impacts to Section 4(f) resources. The Proposed Action includes all possible planning to minimize harm to the National Register-eligible Lechmere Viaduct, Lechmere Station, Somerville Automobile Company, and the Reid and Murdock Company Warehouse, as well as to avoid all other Section 4(f) resources within the project study area.

The demolition of the Lechmere Viaduct is unavoidable as there are no practicable alternatives to build the Proposed Action. Several alternative locations for Lechmere Station, Ball Square Station, and Gilman Square Station were considered, including the No-Build Alternative, but none were found to be feasible or prudent while also satisfying the Purpose and Need of the project.

MassDOT proposes to minimize harm and mitigate unavoidable impacts of the project to these Section 4(f) resources with the completion of the mitigation measures outlined in the MOA (Appendix G, *Memorandum of Agreement*) between the FTA, MassDOT, the MBTA, MHC, the BLC, the Cambridge Historic Commission, the Medford Historical Commission, and the Somerville Historic Preservation Commission.

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# 9 Distribution List

In accordance with 23 CFR part 771.119 of the FTA's *Environmental Impact and Related Procedures*, this EA is being distributed to the following governmental agencies and other parties.

The public review period for this EA will last 45 days, beginning on October 5, 2011. Thus, written comments are due by November 18, 2011.

Copies of this report will also be posted on the Project website (http://www.mass.gov/greenlineextension) and also made available at the listed libraries. To request a copy of this document, please contact Regan Checchio at (617) 357-5772 or at rchecchio@reginavilla.com.

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Representative Edward Markey
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